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UNITA' DI VALUTAZIONE TECHNOLOGY ASSESSMENT - U.V.T.A.

Final Report

EVALUATION OF A NEW TECHNOLOGY IN

THE REPROCESSING OF MEDICAL INSTRUMENTS

Client:

BICARJET S.r.l. – Padua (Italy)

September 2012

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Introduction

The technology proposed by BICARjet S.r.l., consists in the surgical instruments treatment post-use, with a jet of sodium bicarbonate granules, using low pressure compressed air in order to clean their surface in an effective and thorough manner. The adoption of such a system replaces the manual brushing which frequently is ineffective due to a variety of possible causes. Among these are frequently the unsmooth and complex surfaces of many instruments, their relatively small size and difficulty to handle, and the fact that normal human beings are bound to err from time to time.
The granules of sodium bicarbonate instead, because of their very small size, which can vary from 500 and 50 microns, will strike the surfaces in a uniform and continuous way, even reaching inside deep crevices and removing the contaminants adhering to the surfaces. The mechanical action of the abrasive granules does not cause damages to the surface because the kinetic energy used to clean them is absorbed by the same granule that during this process will self destroy itself (information based on studies carried out at the University of Trento, Department of Engineering Materials and Industrial Technologies).
The sodium bicarbonate has no corrosive action on the treated surfaces and is completely soluble, as well as biodegradable. Also is not harmful to the environment and above all it is not dangerous for the operators. The unique proprieties of this innovative technology are specifically intended to eliminate the common concern among surgeons that many reusable surgical instruments cannot be sufficiently cleaned manually and consequently it is preferable to treat them as if they were instead single-use disposable items.

Targets

The first objective of this study is to evaluate the effectiveness of the technology proposed by BICARjet S.r.l. in the mechanical removal of the various particles of bone, tissue, and other debris that after any surgical procedure are normally found on the surgical instruments used.
Based on the outcome of this assessment, the second objective is to define a proper protocol in the use this technology that specifies the distances, pressures, times and particular types of baking soda used in order to obtain the most effective mechanical cleaning procedure possible.

Materials and methods

MELTRON®, a salt compound with a bicarbonate base used in the mechanical cleaning procedure being tested, depending on the granulation is classified either as "GG" (standard compound) or

"FX" (finer compound). The chemical and alimentary analysis of both compounds is being provided in an Attachment.

This compound is delivered, by means of compressed air, (consumption data in an attachment), thanks to a cleaning system called "SOBIJET ®" (image 1) consists of a compact cabin called "Compact 900", which is also at the basis for innovation technology proposed by BICARjet S.r.l., and whose dimensions were easily adapted to the logistical needs of the premises so as not to interfere with the normal activity of those areas.

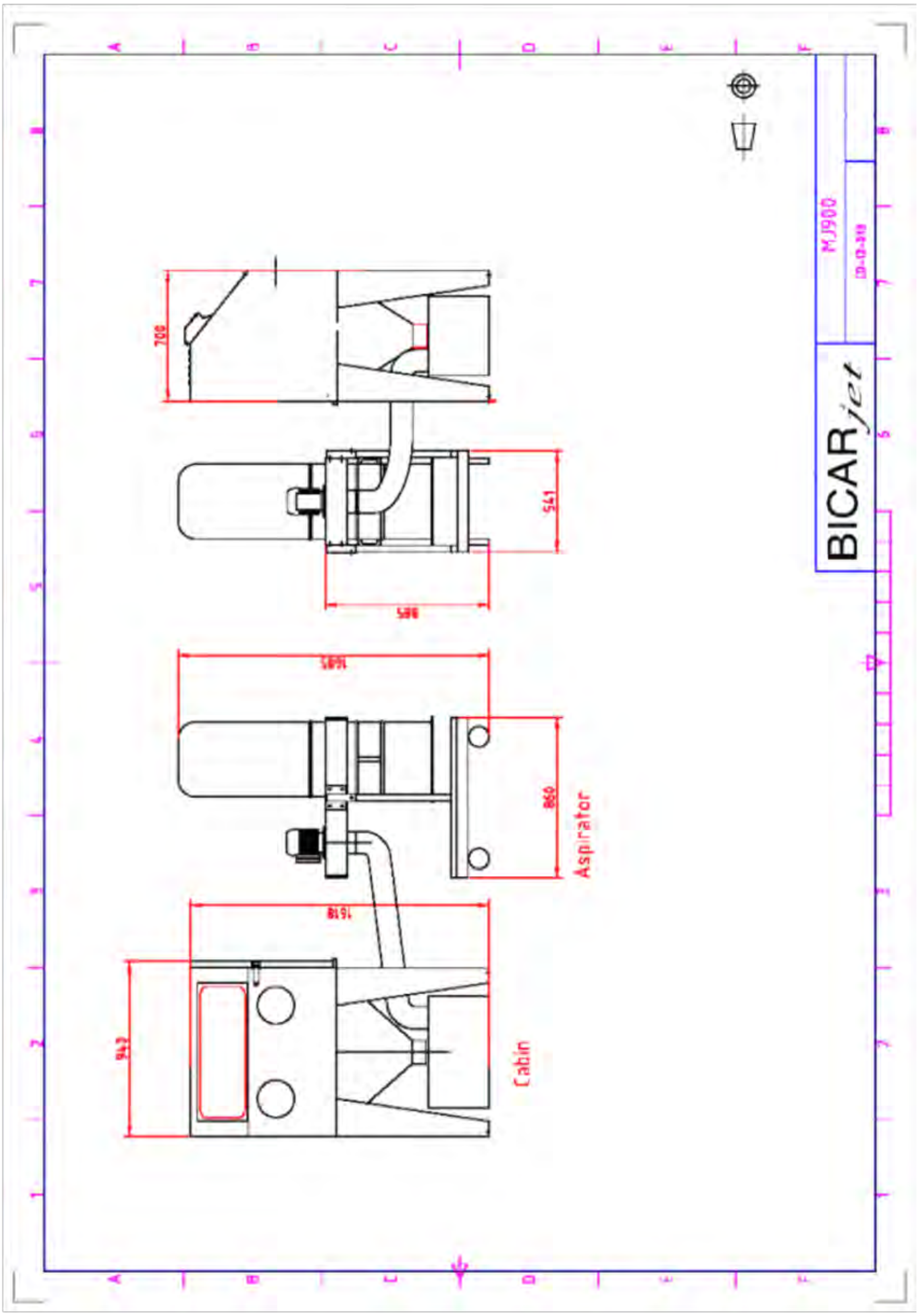

Image 1. *Compact 900, cleaning system*

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The cabin is composed by a 2 mm. thick sheet of AISI 304 stainless steel, with a side loading door locked by hooks and a window in tempered safety glass with wiper and exterior lighting. The operator of the Compact 900 is provided with latex gloves and two working hoses with two different nozzles (MICROJET and MINIJET) by which the product MELTRON® is dispensed depending on the degree of accuracy desired. A compressed air gun, positioned externally, will also allow the operator to remove from the surface of the instruments being cleaned any residue of bicarbonate that may be present after the spraying of the MELTRON®.

The system is coupled with a power supply unit controlled by the operator by means of a pneumatic pedal control, consisting of a hopper, a dosing system of the compound of MELTRON® with a double Venturi "HPV" developed and patented by BICARjet S.r.l.

A flexible aspiration hose guarantees the removal of any dust particles present in the cabin to the dust suppressor. See the exhibit 6 for the additional technical features of a typical Compact 900 cabin.

Initially various surgical instruments were classified in terms of their size, type, volume, usage by department and disposable versus reusable. Only after the instruments were classified in this manner the samples to be tested were chosen. In addition the Purchasing Department has provided information on types and volumes of the instruments used by each surgical department. Being a research project, separate from the regular processes of patient care, it was necessary to supervise the operating rooms and assume responsibility for the collection, packaging and transport of the samples. For the same reason it was also necessary to obtain the guidance of the Preventive Medicine department on how to best minimize all possible related risks.

The equipment was placed, with minor modifications, in a room of the hospital and special arrangements were made so that it would not interfere with the normal activities of the hospital.

The tests were performed on a total of 47 surgical instruments, of which:

- 33 disposable surgical tools from Otosurgery of the Hospital of Padua used for cochlear implants, of which, 13 were finned in tungsten carbide and 20 in diamond-coated medical grade tempered steel.

- 10 reusable stainless steel surgical tools coming from Neurosurgery of the Hospital of Padua and used for craniotomies, of which: 4 finned, 1 diamond-coated and 6 of the Craniotome type (of which one was already decontaminated with the standard procedure in force within that department).

- 4 disposable surgical tools from Day-surgery of the Hospital of Padua used for surgery on shoulders and knees, produced with special medical grade hardened steel whose surfaces are coated with a highly resistant sheath of polycarbonate.

The above considerations are summarized in the table that follows as Exhibit, in which has been included, along with information on the type of instrument and its origin, the related storage time, that is, the time elapsed from when the instrument was last utilized to when it was mechanically cleaned by the method which is the object of this study. The abbreviation in the first column of the table is to identify the instrument. This abbreviation is the same that has been used to monitor it during the entire test procedure; as to the instruments collected, the following assumptions were made:

1. Ordinary use.

2. Storage of the surgical instruments by the staff of the operating unit in sterile test tubes so as to avoid any external contamination.

3. Recovery of the instruments in a test tube, application of an identifier, based on the operating unit and collection of information on its type.

4. Once at the site used for the mechanical cleaning process, the tool was removed from the sterile tube and underwent the following process:

   a. Photography with digital camera Nikon D300.

   b. Scans and photographs with digital microscope Dino Light, magnification 500x.

   c. Procedure for mechanical cleaning using the compound MELTRON ® inside the cabin Compact 900 described above.

   d. Additional scans and photographs with digital microscope Dino Light, magnification 500x.

   e. Storage of the just cleaned instrument into a new sterile tube with a tag identifying both the item and the type of cleaning process utilized.

To evaluate the reduction in the bacterial load as a result of mechanical cleaning process being tested, thanks to the collaboration of the Department of Microbiology of the Hospital headed by Prof. Giorgio Palù, a test was conducted as follows:

1) Two new ribbed drill bits GE407R 4mm (AESCULAP) in stainless steel taken from the Department of Neurosurgery of the hospital and brought to the Department of Microbiology.

2) In the Microbiology Department a culture broth was prepared containing strain of Escherichia coli ATCC 25922 and incubated at 37 °C for 18 hours. The culture thus obtained was diluted until the bacterial count was about 10^6 of bacteria.

3) The drill bits were entered and left for 1 hour at room temperature and after left to dry for 2 hours in a plate at 37 °C.

4) One of the two bits was decontaminated with the compound MELTRON®, while the other was not.

5) The drills were inserted in a Petri dish with culture medium (ORI CHROMAGAR ORIENTATION Becton-Dickinson) and incubated for 48 hours at 37 °C.

6) Reading of the dishes in order to assess the bacterial growth.

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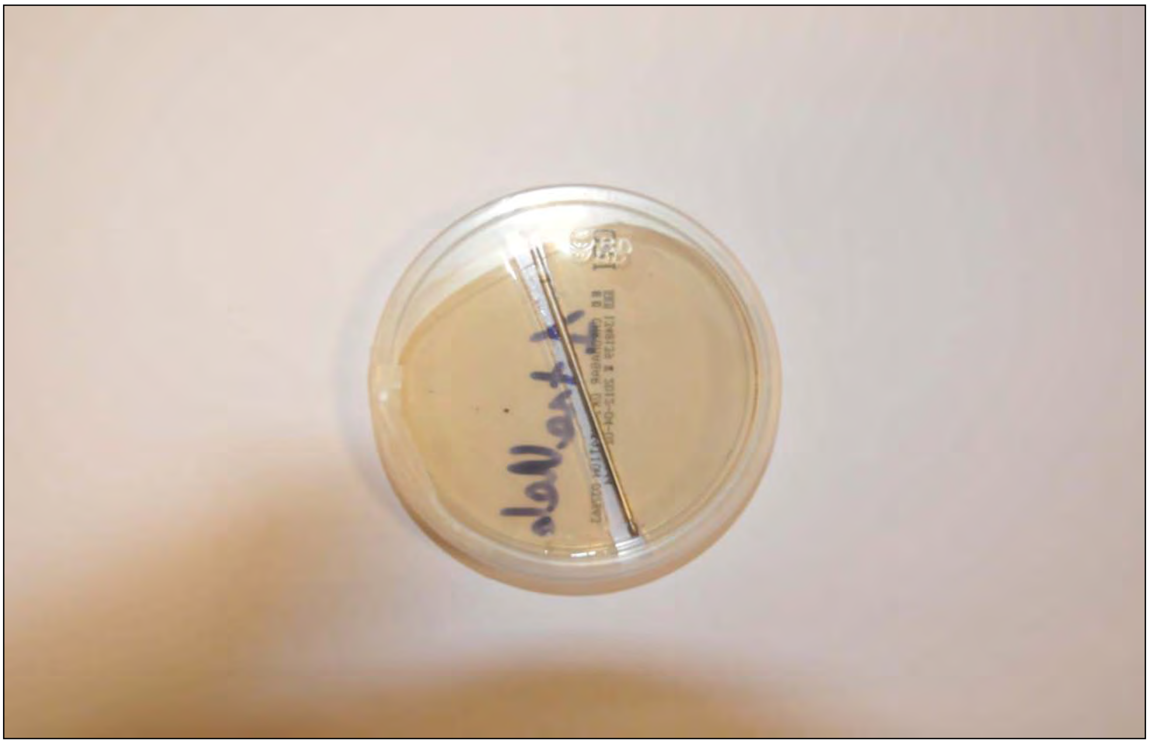
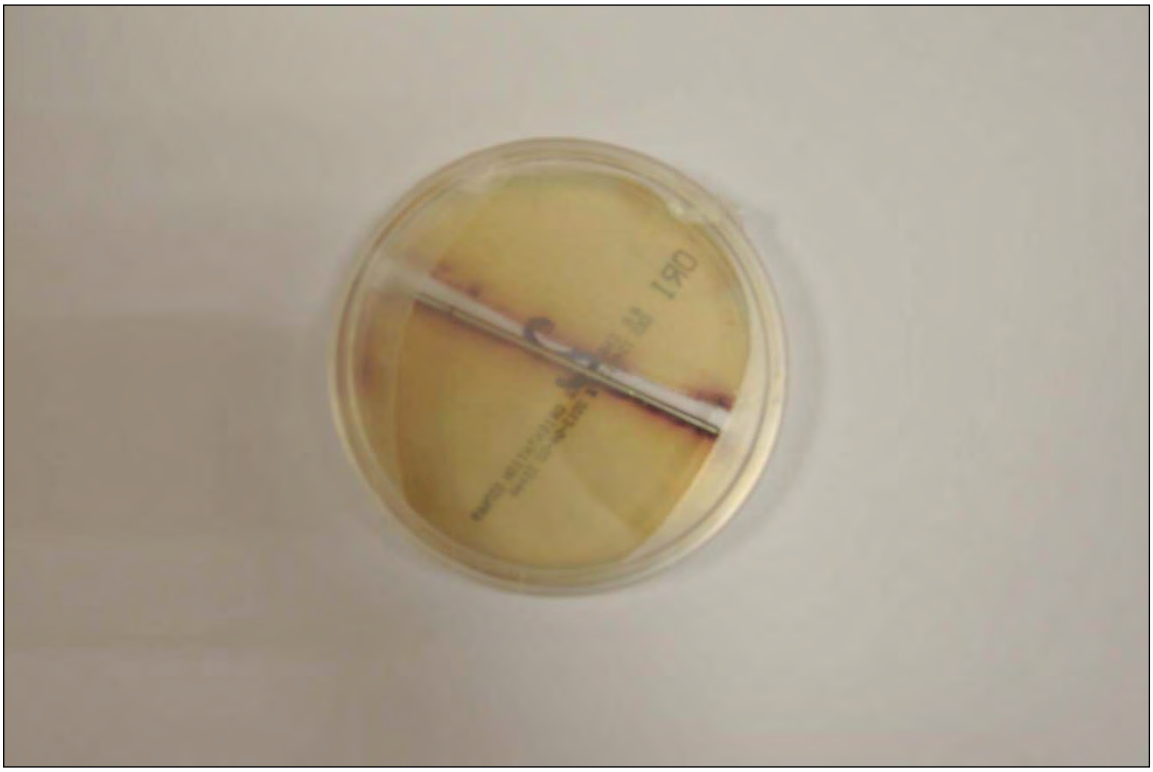
Microbiological control of drill bits

- Strain of Escherichia coli ATCC 25922.
- A broth inoculated with the strain and incubated at 37 °C for 18 hours
- The culture thus obtained was diluted until the bacterial count was about 10^6 of bacteria.
- The drill bits was inserted and left for one hour at room temperature and then left to dry for two hours in a plate at 37 °C
- One was treated, the other not
- The drill bits were inserted in a Petri dish with culture medium (ORI CHROMAGAR ORIENTATION Becton- Dickinson) and incubated for 48 hours at 37°C
- **Reading:**
- Treated dish: no growth
- Non-treated dish: 20 E. coli strains

Dr.ssa L. Rossi



The Petri dish containing with the drill bit decontaminated with the MELTRON® compound: No growth



The Petri dish containing with the untreated drill bit: 20 colonies of E. Coli

The cleaning procedure proposed by mechanical BICARjet Srl was further investigated by analysis done with the electron microscope (SEM) conducted within the Complex Pathology Unit of the Hospital of Padua and at the Laboratory of Special Pathology, directed by its Director Prof. Marialuisa Valente . The electron microscopy and X-ray microanalysis are indeed valuable tools for evaluation of protocols for disinfection, cleaning and sterilization of reusable devices. The scans were performed first on the instrument contaminated after its use and then on an identical instrument (same model, same operating unit, the same intervention, the same time in storage) used and decontaminated with the salt compound bicarbonate based MELTRON®. This has been made possible due to the high standardization of interventions within the same operating unit.
In detail, the tools analyzed by electron microscopy before and after the mechanical cleaning were (Exhibit 2):

- Drill bit, finned, identifier O11, E8240 LSO 4 MM (Conmed Linvatec), Otosurgery
- Craniotome, identifier N7, GE520 R (Aesculap), Neurosurgery
- Diamond coted bit, identifier O13, E5220 2 MM (Conmed Linvatec), Otosurgery

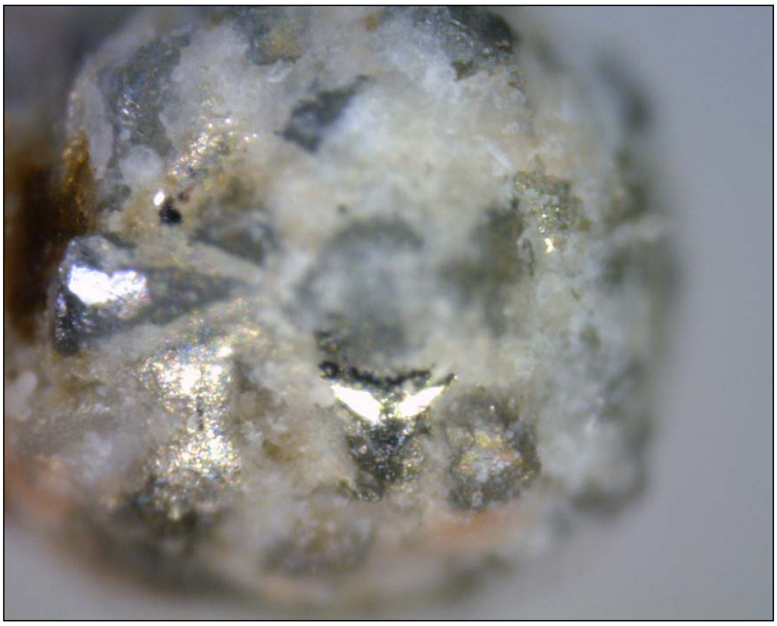
Results

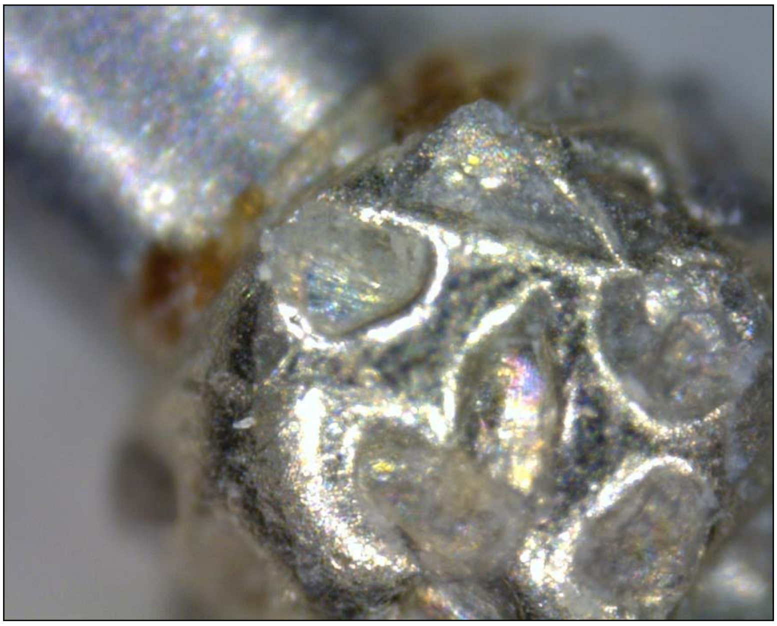
In this first phase are identified n. 47 specimens treated with the technology of mechanical cleaning BICARjet S.r.l. The results of the application of technology BICARjet S.r.l. for the mechanical cleaning of surgical instruments are shown below with the aid of images produced by the microscope Dino Light. Shown are the photos of the instrument in question after its use, before and after going through the Cabin Compact 900 and being exposure to the treatment with sodium bicarbonate (MELTRON®); in this section we have produced a summary of the total sample of 47 pieces, divided between the different days of testing.

Day 1

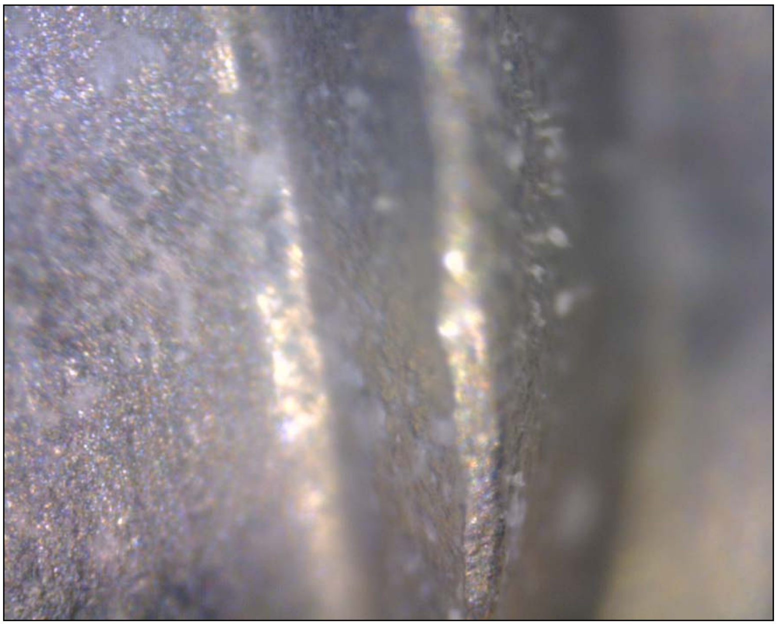
During the first day, it was used the bicarbonate MELTRON® GG, at a pressure of 3 bar at the nozzle, at a distance from this of about 10 cm and for a duration ranging from instrument to instrument and in any case ranging between 5 and 30 seconds .

Shown in detail below are the pictures taken with a digital microscope of a diamond coated bit model E5210 of 1 mm used in Otosurgery (ID O5) before and after the mechanical cleaning (15 seconds), which occurred after 4 days use.



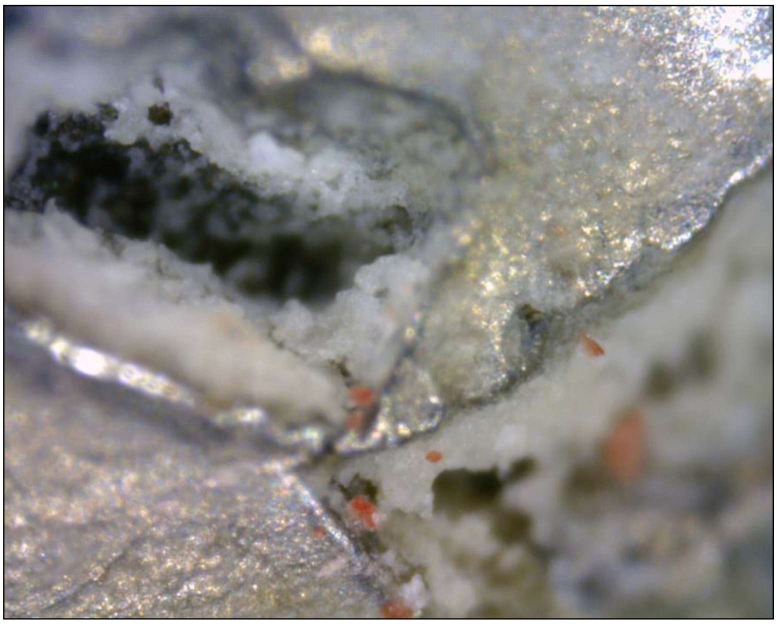


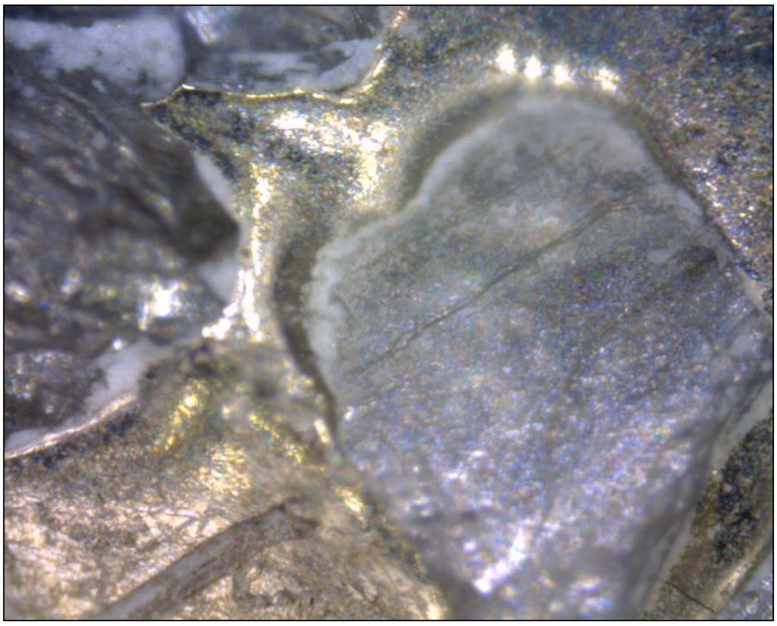
Shown below are the detailed pictures taken with a digital microscope of a finned bit model GE504R 2.3 mm used in neurosurgery (ID N2) before and after the mechanical cleaning (30 seconds), performed after one day of use in the ward.



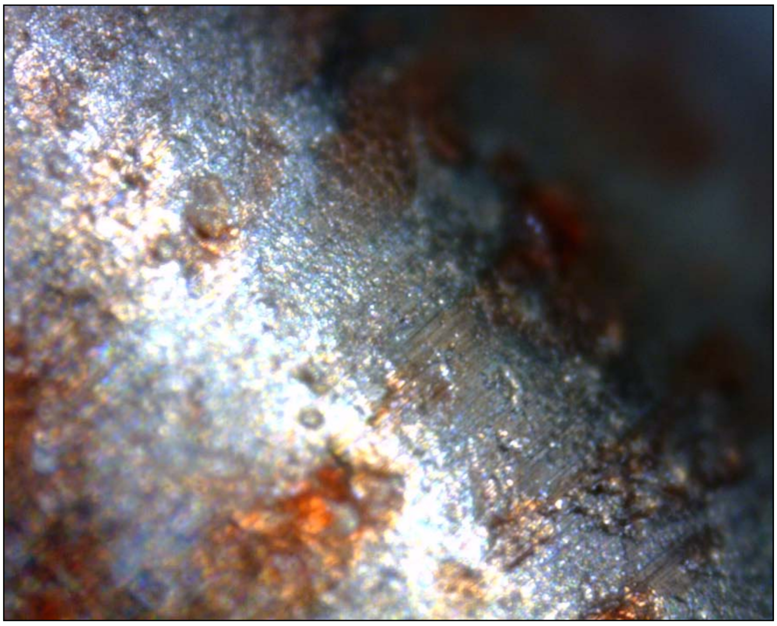
Day 2

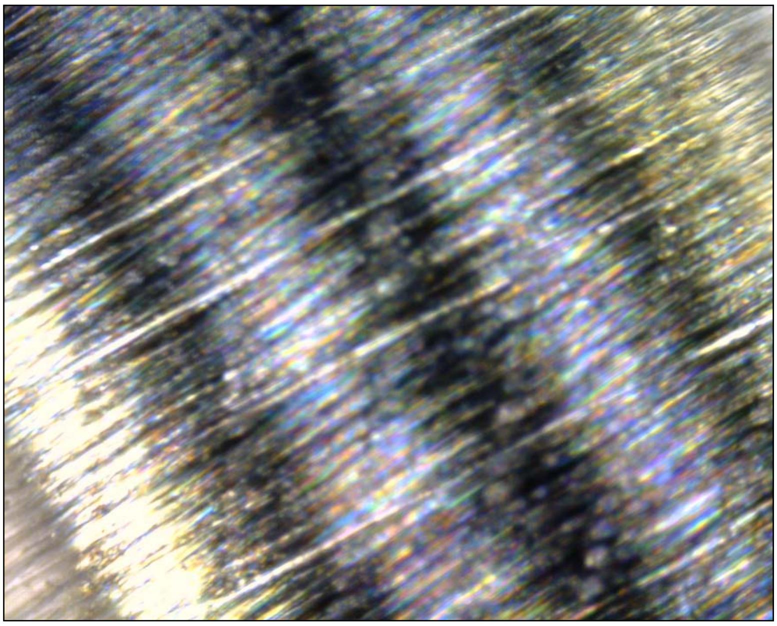
On the second day, depending on the size of the instrument, we either used the bicarbonate MELTRON® GG or the bicarbonate of finer consistency MELTRON® FX; testing the latter on the smaller size bits. The pressure remained at 3 BAR at the nozzle, while the times of mechanical cleaning were all greater than 24 seconds but less than 120 seconds. The distance from the nozzle, as well as the type of nozzle used, have been variable. On this day, for one instrument, we tested the rinsing at the end of the mechanical cleaning.
Following are detailed pictures taken with a digital microscope of a diamond-coated bit model E5130 of 6 mm used in Otosurgery (ID O6) before and after the mechanical cleaning which occurred 1 day after its use (115 seconds, during which different distances, type of bicarbonate and type of nozzle were used).





Following are pictures taken with a digital microscope of the shank of a diamond-coated bit model E5050 of 5 mm used in Otosurgery (ID O7) before and after the mechanical cleaning implemented 1 day after its use in the ward. (35 seconds, with MELTRON® GG, at 10 cm distance from the nozzle MINIJET® with rinsing at the end).





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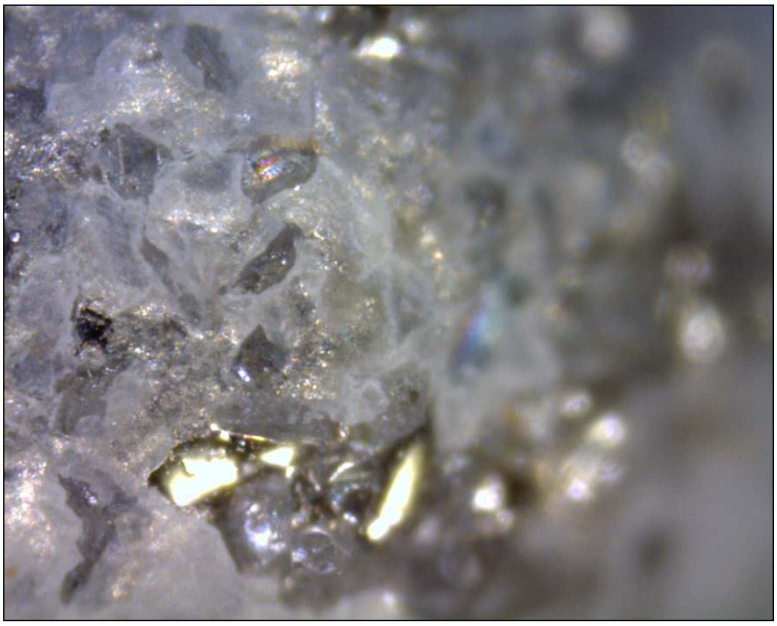
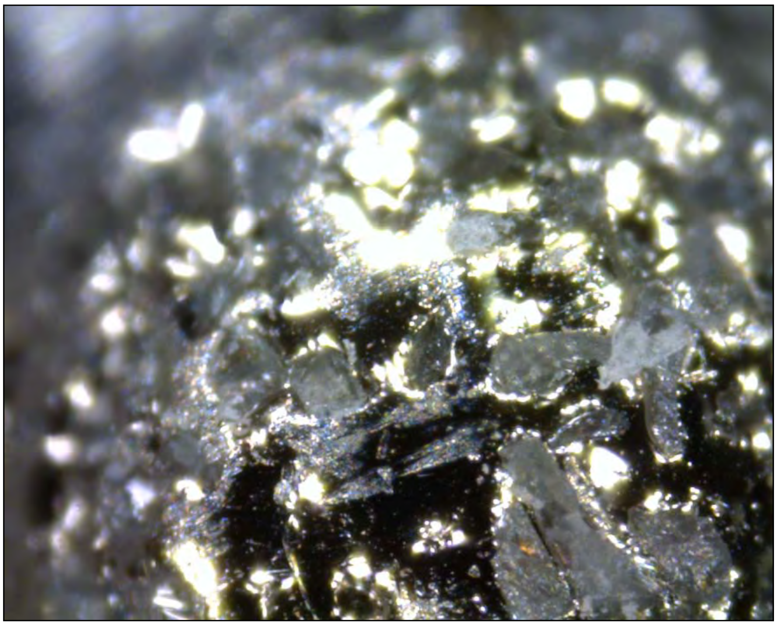
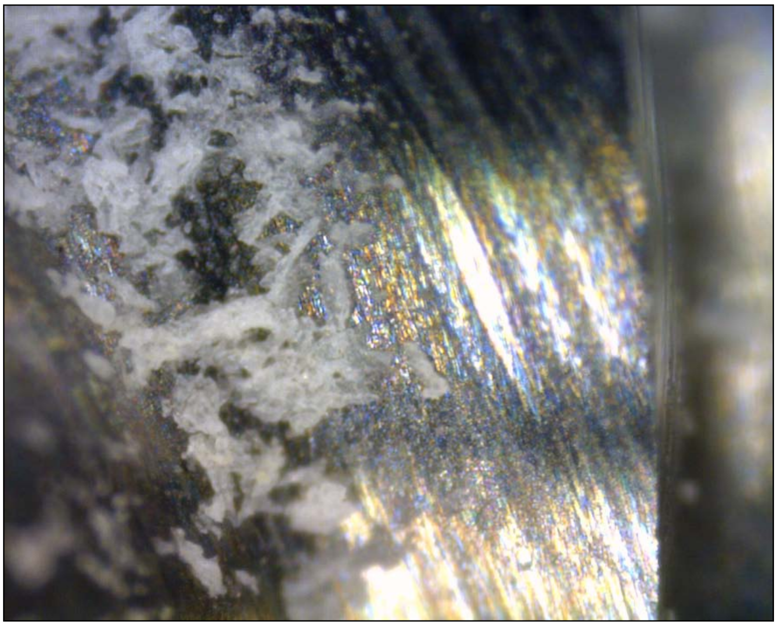
Day 3

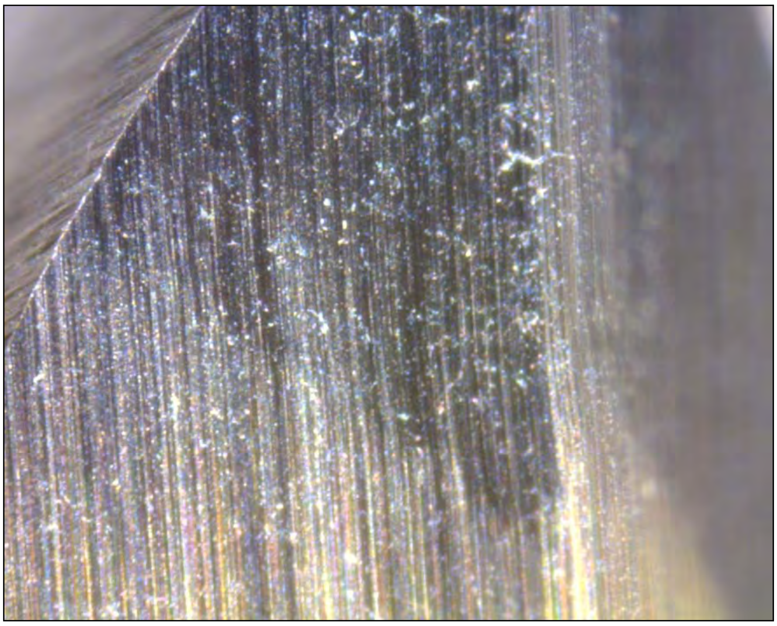
In the third day, depending on the size of the instrument, we continued to test the use of bicarbonate MELTRON® GG and alternatively the bicarbonate of finer consistency MELTRON® FX. The duration of the cleaning has begun to average at about 30 seconds for the cutters coming dall'Otosurgery; still to be defined are instead the times for the craniotome type of instrument of Neurosurgery. The pressure remained at 3 BAR at the nozzle, except for a test with 4 BAR at the nozzle, while the distance, as well as the type of nozzle used, have been variable. Rinsing at the end of the mechanical cleaning was done for all instruments.
The pictures of the digital microscope that follows are relative to a diamond-coated bit model E6220 of 3 mm used in Otosurgery (ID OL3) before and after the mechanical cleaning which occurred after a few hours after its use (50 seconds with MELTRON® GG, at 10 cm from the nozzle MINIJET®, to which followed 37 seconds with MELTRON® FX at 2/3 cm from the nozzle MINIJET® with a pressure of 4 BARS).





In detail, the photos to digital microscope of a milling cutter finned model E8040LSO 4 mm used in Otosurgery (ID OL5) before and after the mechanical cleaning (27 seconds with MELTRON® GG, at 10 cm from the nozzle MINIJET®), operated after a few hours of use.





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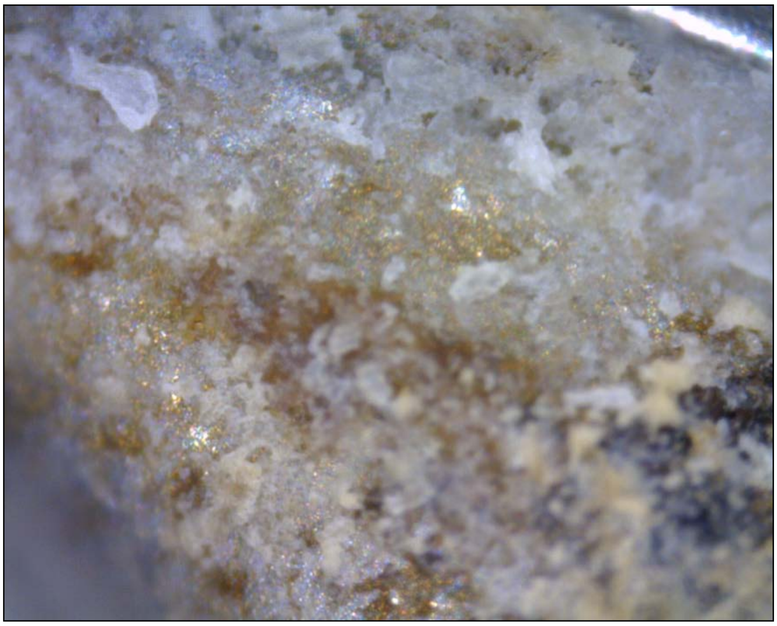
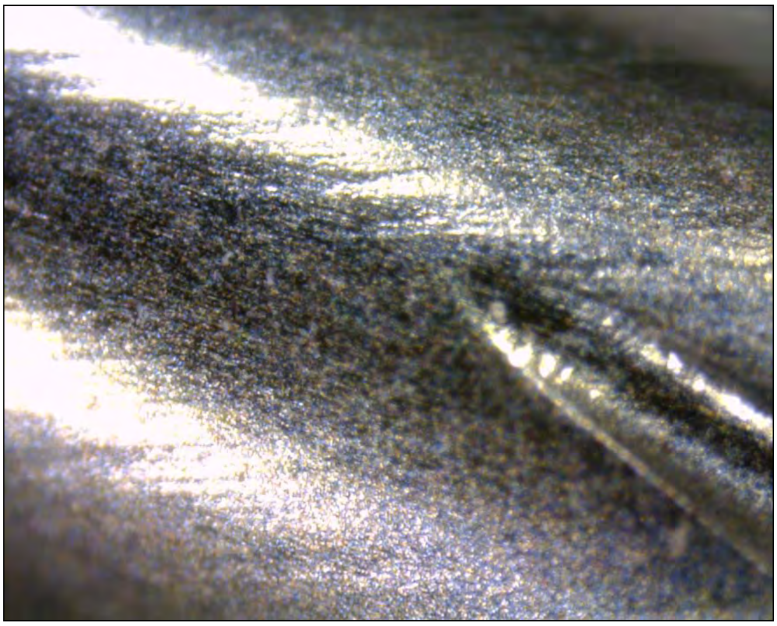
The table shows the photos to digital microscope of a craniotome model GE520R used in Neurosurgery (ID N6) before and after the mechanical cleaning (48 seconds with MELTRON® GG, at 10 cm from the nozzle MINIJET ®), on the same day use.





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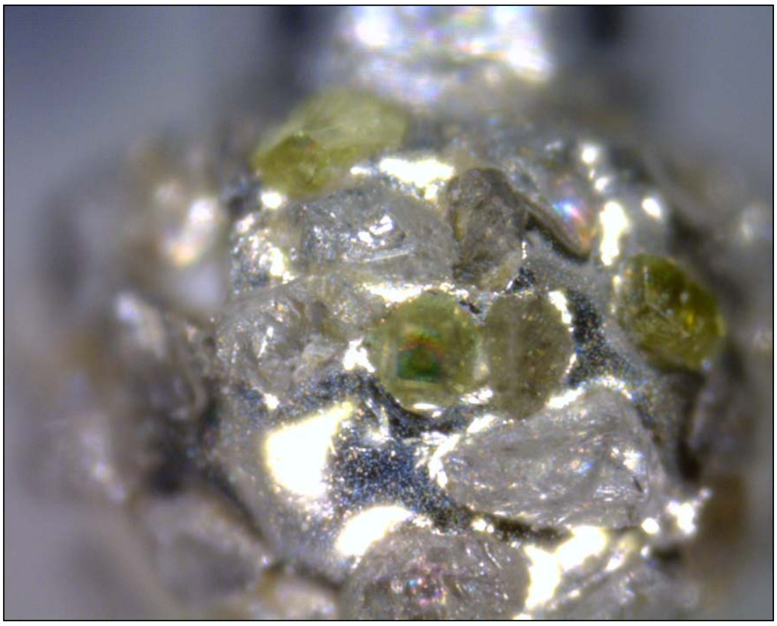
Day 4

In the fourth day they are decontaminated all cutters coming dall'Otosurgery; has continued to use baking MELTRON® GG, in alternation to bicarbonate finer consistency MELTRON® FX, based on the size of the instrument. The time of mechanical cleaning remained on average about 25-30 seconds, with the exception of a test in which they are used in sequence the two nozzles with the respective two types of bicarbonate (about 30 seconds per nozzle). The nozzle pressure has remained at 3 bar, with the exception of a new test with 4 BAR nozzle, while the distance, as well as the type of nozzle have been variable. Rinsing after cleaning has been practiced for all instruments.

Show below are the detailed photos of a digital microscope of a diamond-coated bit model E5210 of 1 mm used in Otosurgery (ID O16) before and after the mechanical cleaning (34 seconds with MELTRON® GG, to 2/3 cm from the nozzle MINIJET®, to which was followed by 28 seconds with MELTRON® FX, in 2/3 cm from the nozzle MICROJET®), performed 2 days after its use.



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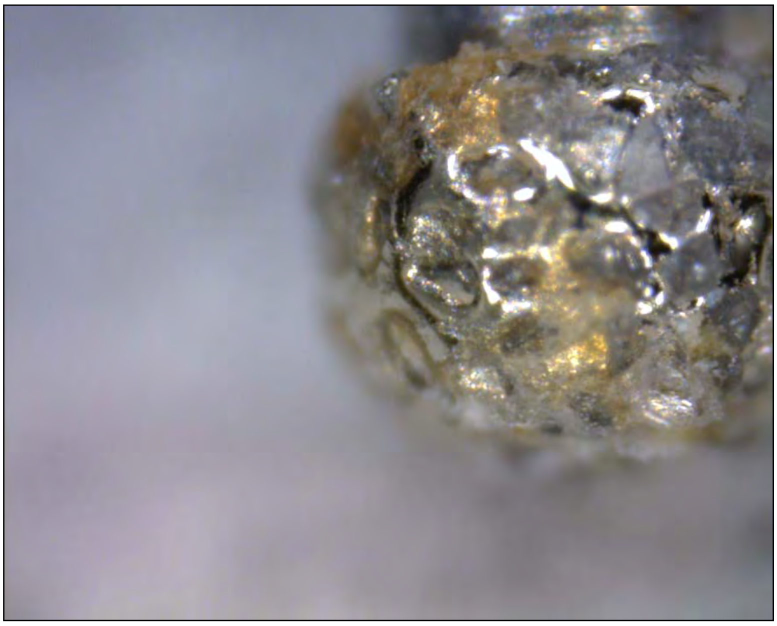
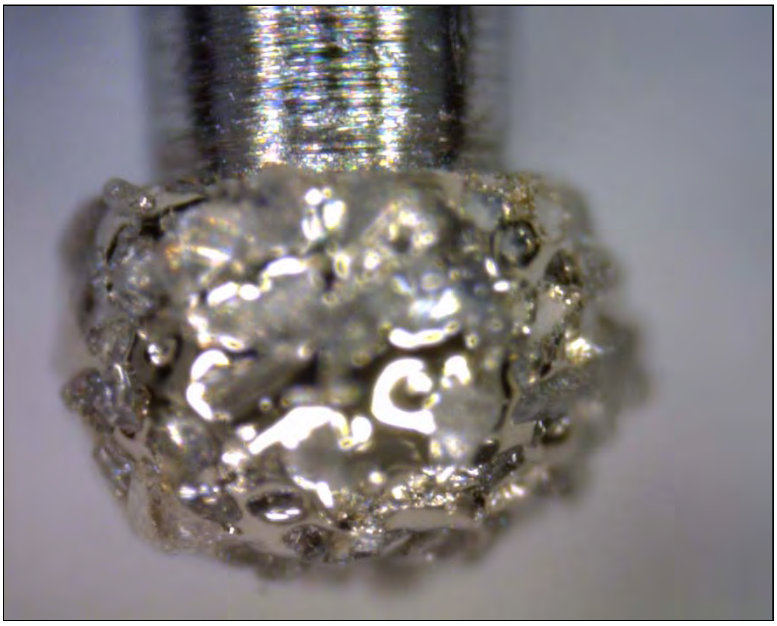
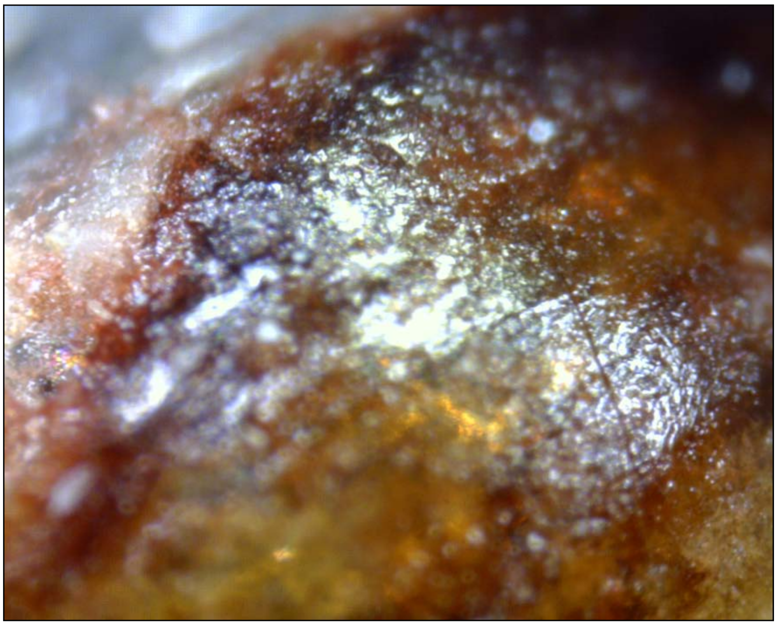
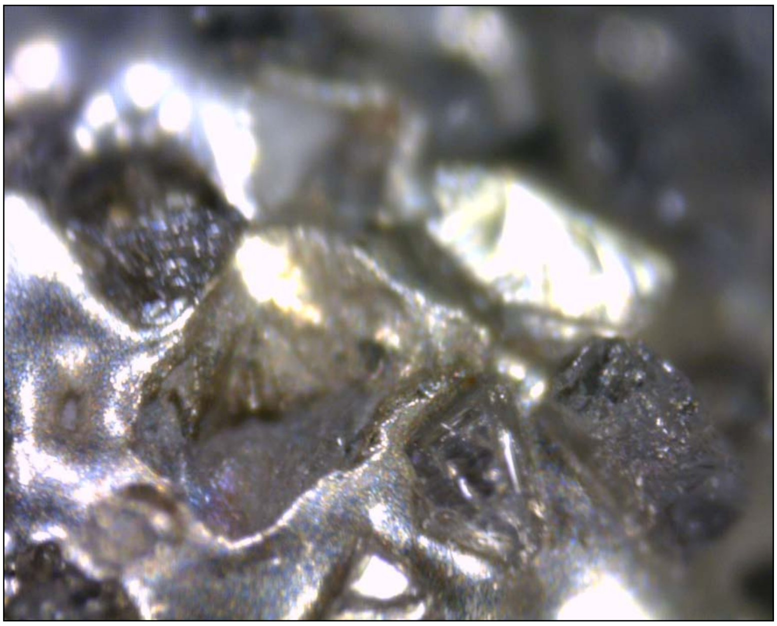
Following are the photos taken with a digital microscope of a diamond-coated bit model E6207 of 0.7 mm used in Otosurgery (ID O15) before and after the mechanical cleaning (33 seconds with MELTRON® FX, to 2/3 cm from the nozzle and a pressure MICROJET® out of 4 bar), implemented 2 days after its use.





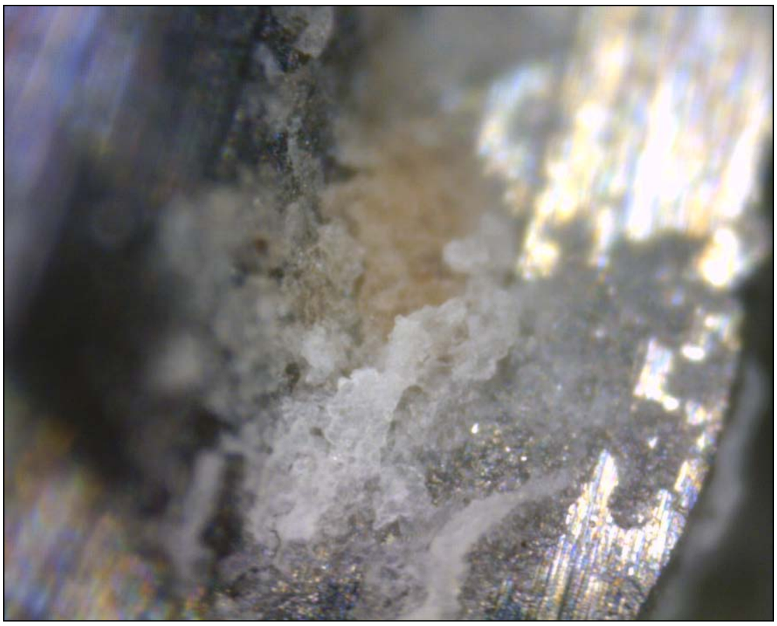
Below are the photos taken with a digital microscope of a diamond-coated bit model E5230 of 3 mm used in Otosurgery (ID O12) before and after the mechanical cleaning (20 seconds with MELTRON® GG, at 10 cm from the nozzle MINIJET®), which occurred 2 days after its use.

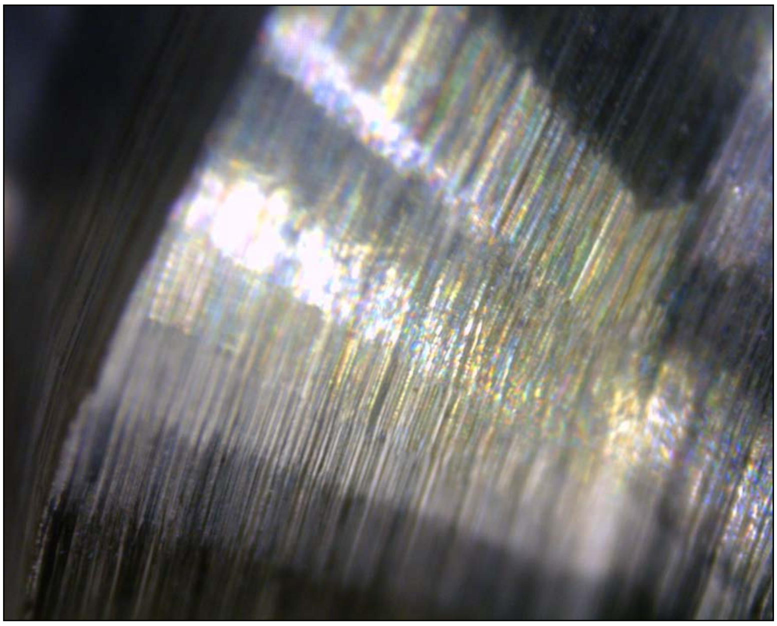




Day 5

On the fifth day we began to further standardize the mechanical cleaning process and testing it on instruments with a greater period of storage after their use (up to 7 days). The sodium bicarbonate MELTRON® GG with the nozzle MINIJET® was used for all instruments at a distance of about 10 cm and an outlet pressure of 3 bars. The time of mechanical cleaning has been an average of about 25-30 seconds, even for instruments of type craniotome. Rinsing at the end of mechanical cleaning was done for all instruments.
Following are the pictures taken with a digital microscope of a finned milling cutter model E8230LSO of 3 mm used in Otosurgery (ID O10) before and after the mechanical cleaning (34 seconds) performed 7 days after its use.





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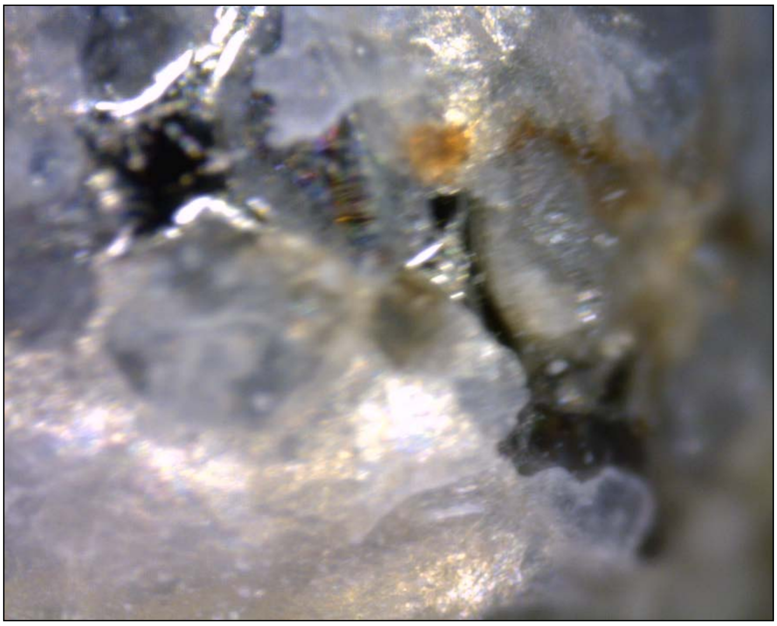
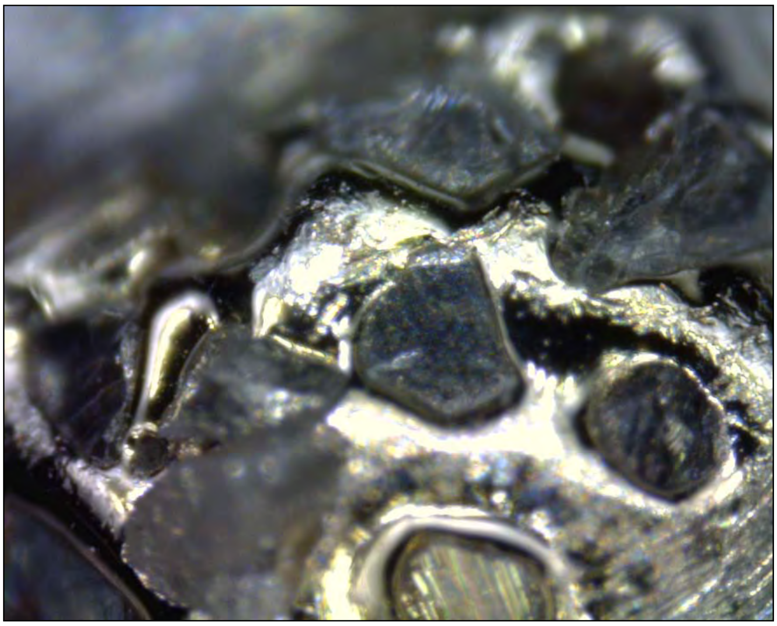
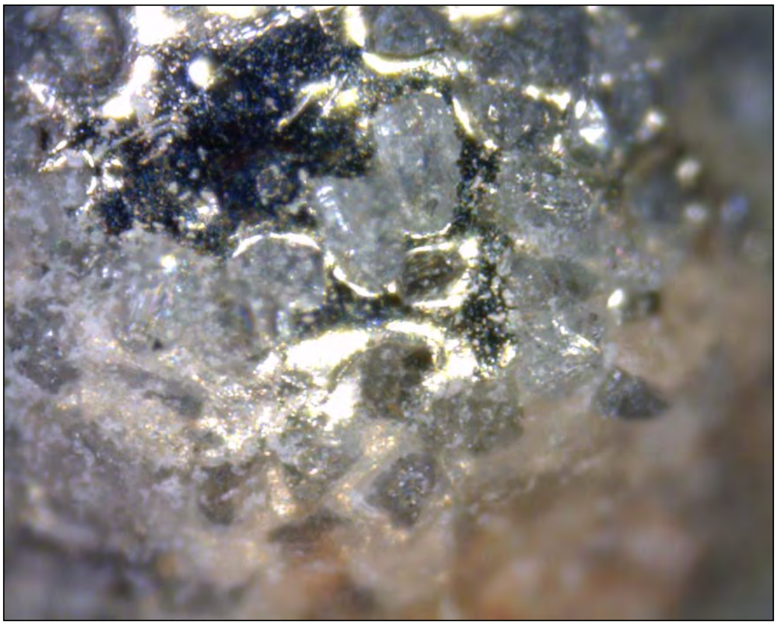
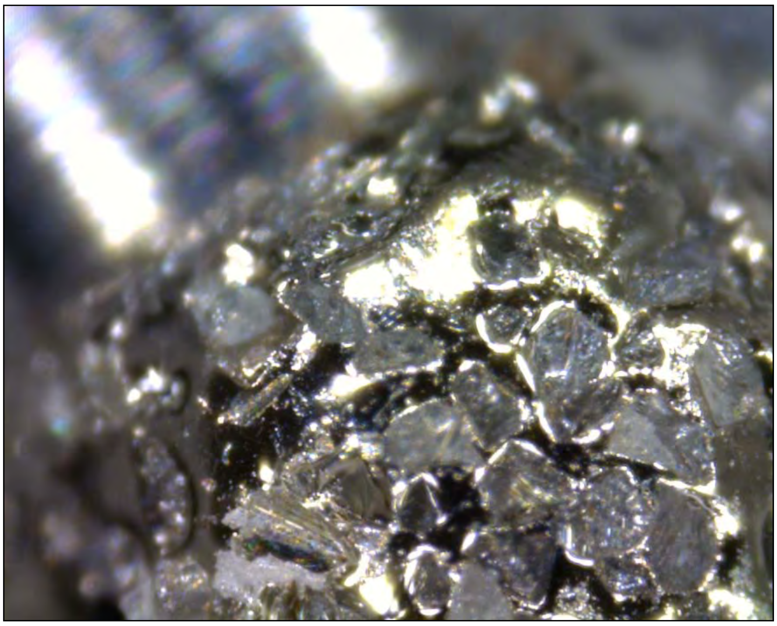
The pictures below taken with a digital microscope are those of a diamond-coated bit model E5220 of 2 mm used in Otosurgery (ID O13) before and after the mechanical cleaning (31 seconds), which occurred 7 days after its use.





Shown below are the detailed photos taken with a digital microscope of a diamond-coated bit, model E6215 of 1.5 mm, used in Otosurgery (ID O14) before and after the mechanical cleaning (25 seconds), done 7 days after its use.





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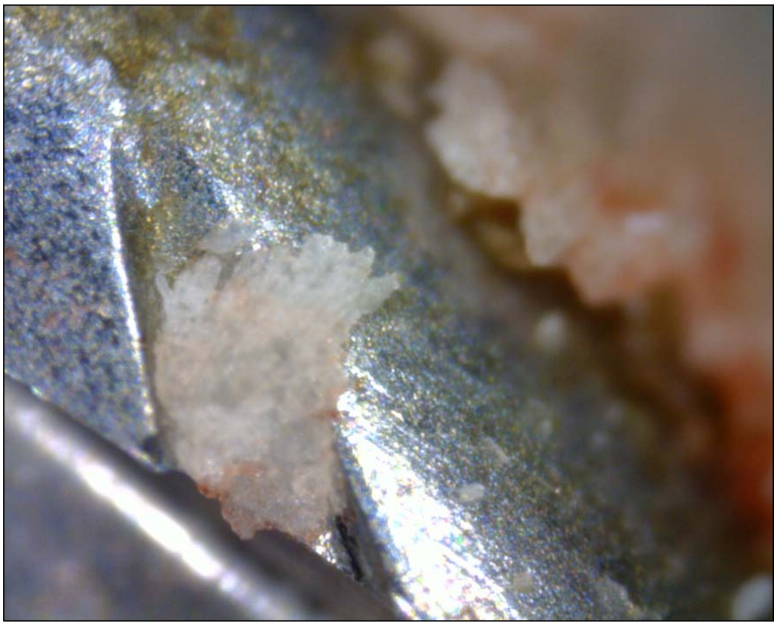
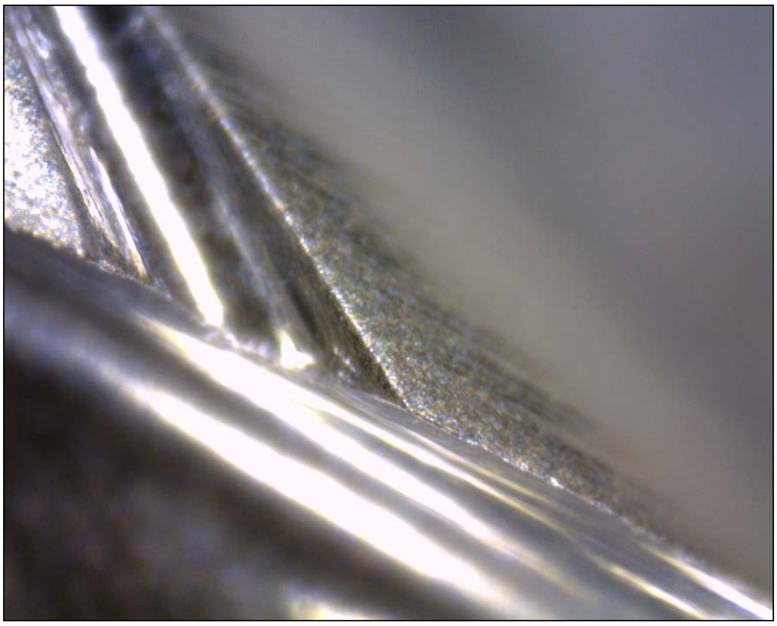
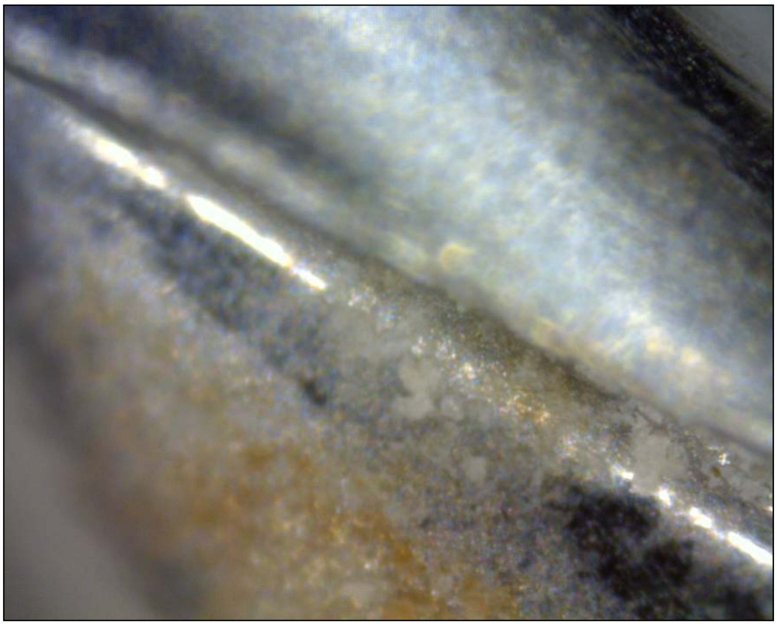
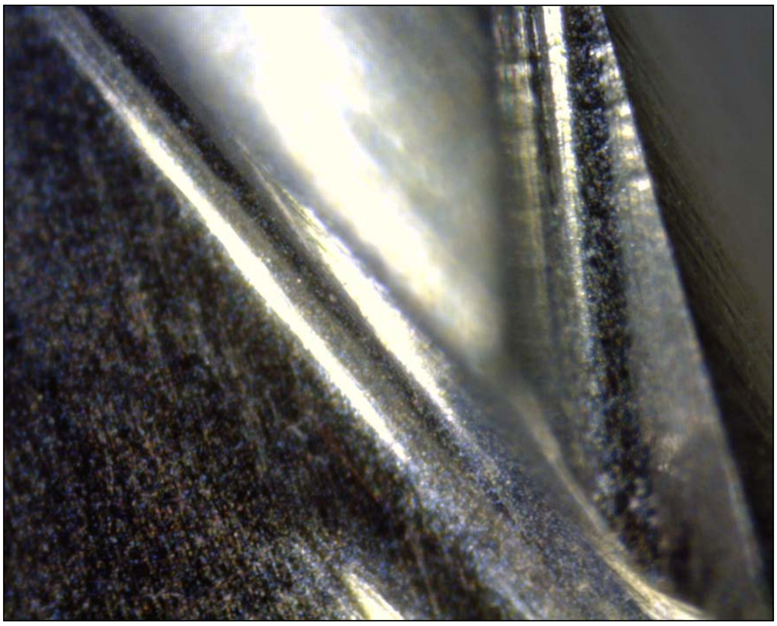
Show below are the photos taken with a digital microscope of a Craniotome model GE520R used in neurosurgery (ID N7) before and after the mechanical cleaning (23 seconds), which took place one day after its use.





The following photos taken with a digital microscope are of a craniotome model GE520R used in Neurosurgery (ID N9) before and after the mechanical cleaning (25 seconds with MELTRON® GG, at 10 cm from the nozzle MINIJET®). In this case, the instrument in question had already been decontaminated in the department according to the standard protocol in use. Protocol that provides for the immersion of the instrument for 15 minutes in a preparation based on quaternary ammonium and enzymatic complex (product concentration of 0.5 % or 25 ml in 5 liters of water), and subsequent brushing of the same. The first picture refers to the craniotome decontaminated in the department with the standard protocol while the second photo show the same instrument after further cleaning using the procedure suggested by BICARjet S.r.l.





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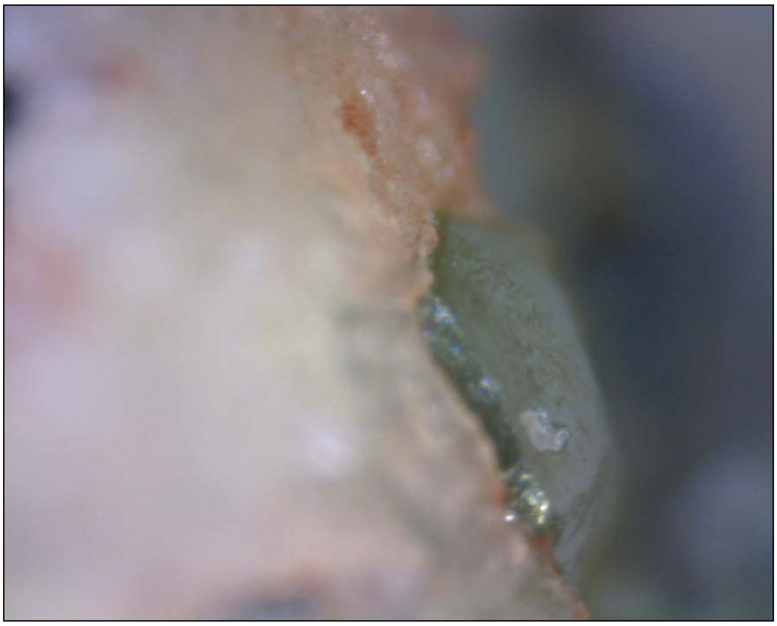
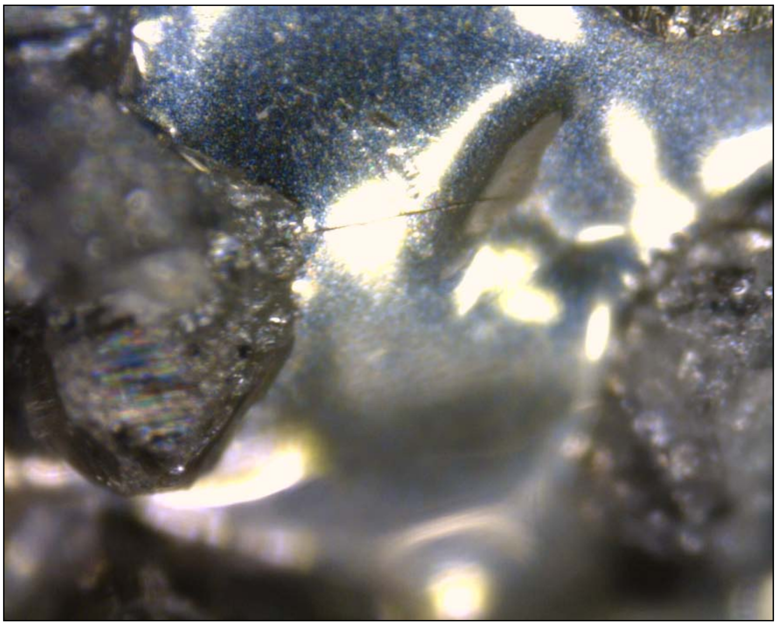
The two pictures below taken with a digital microscope refer to a diamond-coated bit, model E5130 of 6 mm, used in Otosurgery (ID O18) before and after the mechanical cleaning (30 seconds), which took place 1 day after its use.

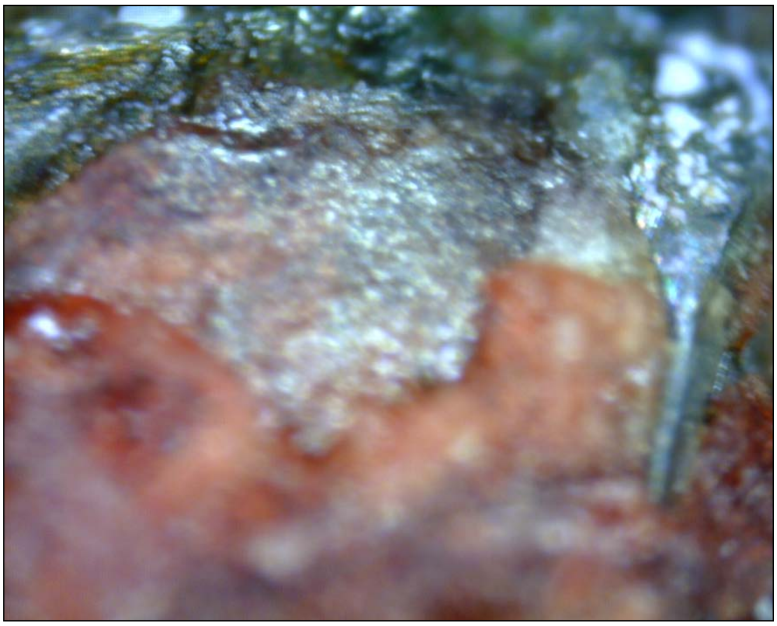


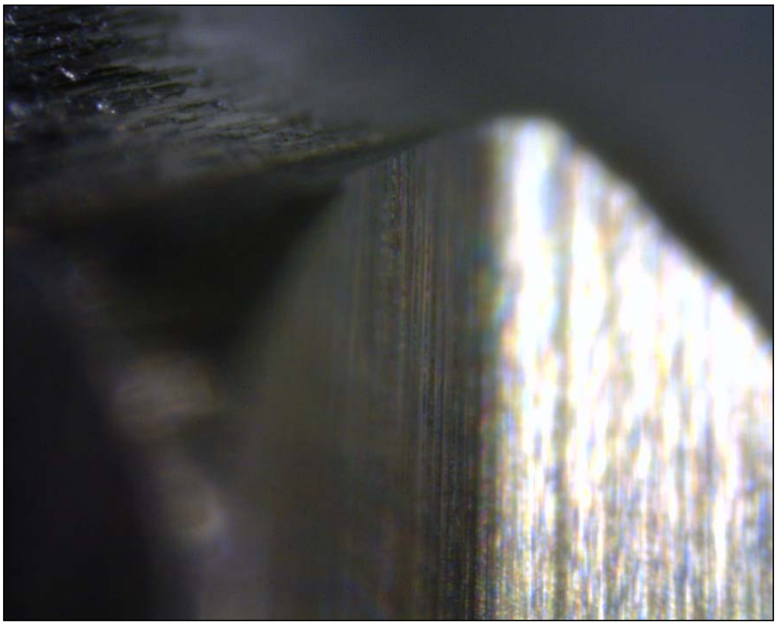


Day 6

The parameters of the procedure for the mechanical cleaning continue to be: bicarbonate MELTRON® GG; nozzle MINIJET®, at a distance from the latter of about 10 cm and a pressure of 3 bars. The mechanical cleaning timing has been an average of about 25-30 seconds. It's always followed by rinsing and during this day the instruments that were decontaminated had been kept in storage for up to 15 days after their use.

The detailed photos below taken with a digital microscope show a finned milling cutter, model E8230LSO of 3 mm used in Otosurgery (ID O21), before and after the mechanical cleaning (29 seconds), implemented 15 days after its use.





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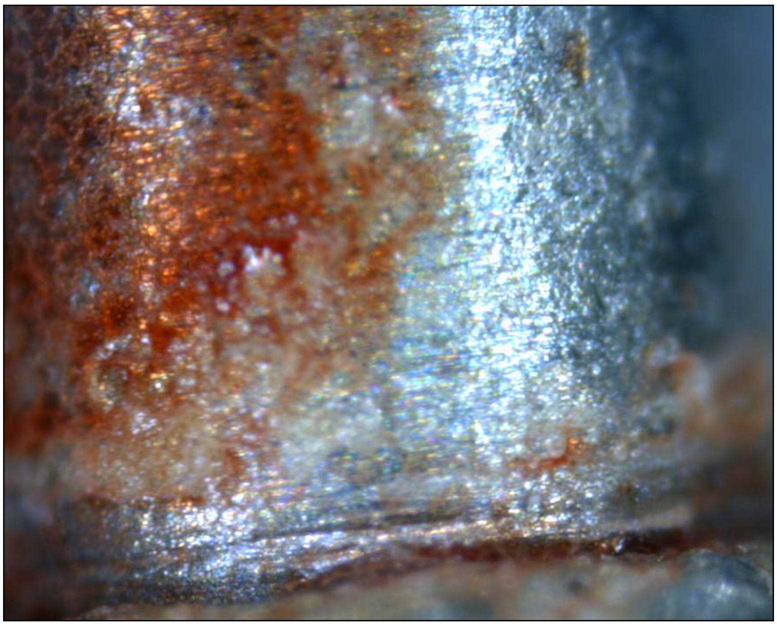
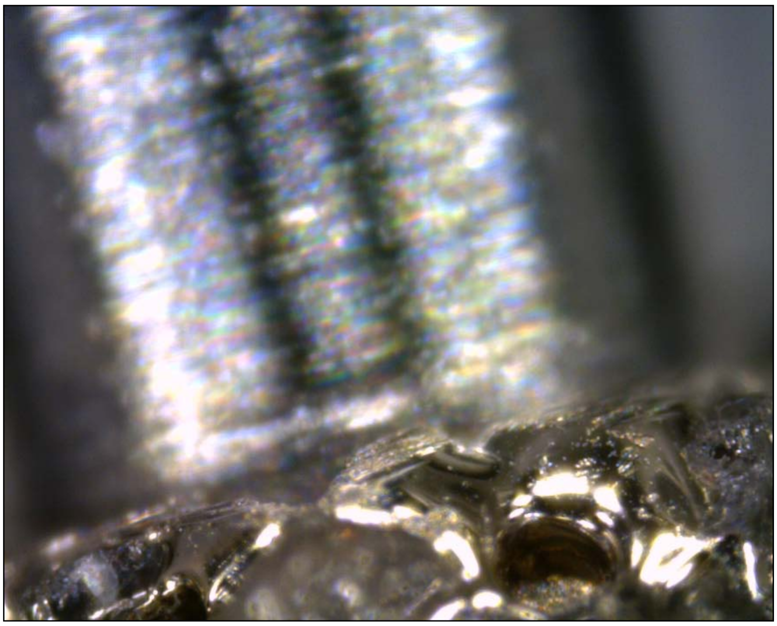
The following pictures taken with a digital microscope refer to a diamond-coated bit, model E5220 of 2 mm, used in Otosurgery (ID O22) before and after the mechanical cleaning (27 seconds), carried out 15 days after its use.





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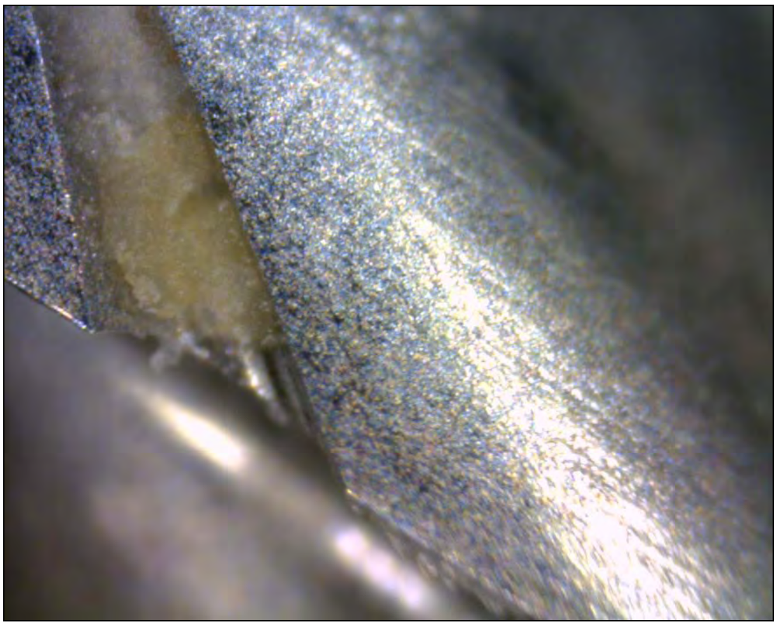
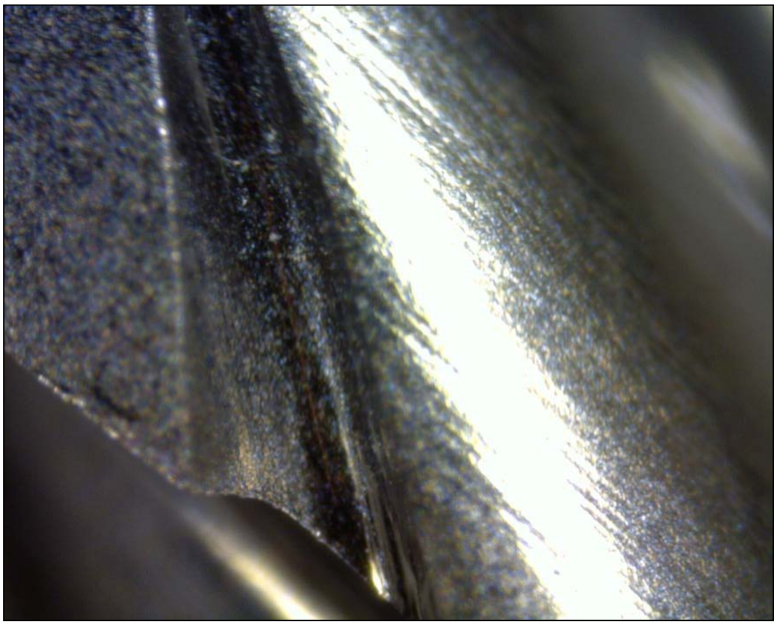
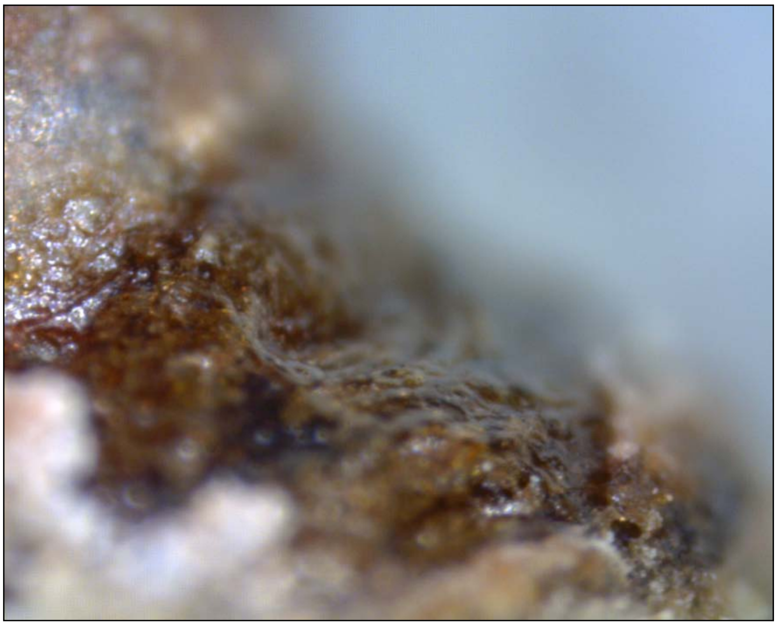
Day 7

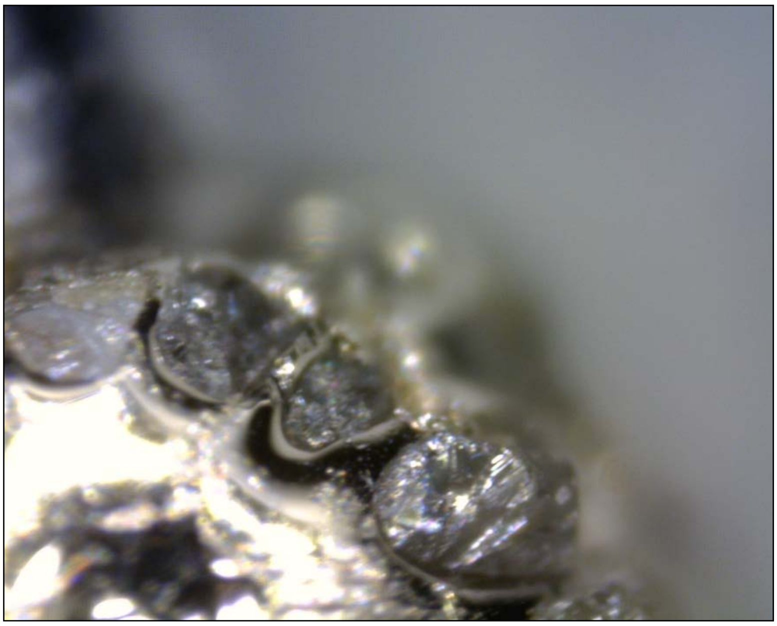
For the instruments coming from Otosurgery and Neurosurgery the procedure for the mechanical cleaning maintain the same characteristics: sodium bicarbonate MELTRON® GG; nozzle MINIJET®, a distance from the latter of about 10 cm, and an outlet pressure of 3 bars. The cleaning time has remained at about 35 seconds.
Below are the photos taken with a digital microscope of a craniotome, model GE520R, used in Neurosurgery (ID N10) before and after the mechanical cleaning (29 seconds), which took place 3 days after its use.



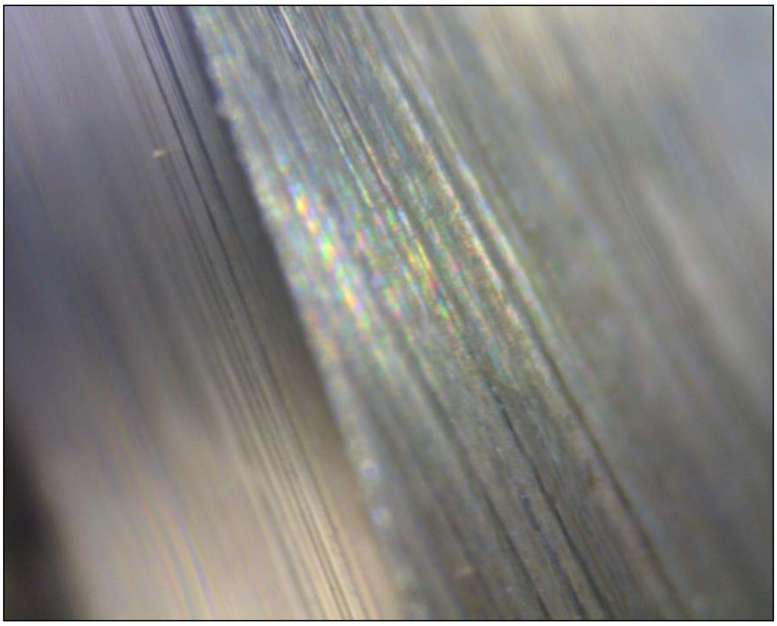


The pictures below taken with a digital microscope show a diamond-coated bit, model E5220 of 2 mm used in Otosurgery (ID O23), before and after the mechanical cleaning (33 seconds), carried out 3 days from being used in the ward.





Following are pictures taken with a digital microscope of a finned milling cutter, model E8250LSO of 5 mm used in Otosurgery (ID O24) before and after the mechanical cleaning (40 seconds), done 3 days after its use.



During the testing days in which all instruments (47) were mechanically cleaned, it was recorded a consumption of about 300 grams of sodium bicarbonate for the nozzle MINIJET® and 250 grams for the MICROJET® nozzle.

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Conclusions

The images produced with the Dino Light microscope (500 X magnification), show that after the application of the procedure BICARjet Srl there is clear evidence of the removal of residues that were present on the surface of the device after its ordinary use; this was also confirmed by scanning with the electron microscope. The proposed technology also does not seem to be particularly impacted either by it to the physical characteristics of the instrument or the period of time it was kept in storage after being used (from 0 to 15 days).
The development of the various elements of the procedure, in terms of pressure, distance, duration, type of nozzle, bicarbonate, and the results obtained, has led us to standardize the parameters for the mechanical cleaning inside the cabin Compact 900 as follows:

a. Bicarbonate type:	MELTRON® GG
b. Equipment:	MINIJET®
c. Operating pressure:	3 bar
d. Distance from the instrument:	from 5 to 10 cm
e. Duration exposure to jet bicarbonate:	30 seconds approx.

Dr. D. Moroni
Mr. Lorenzo Boscolo
Dr. I. Toffanello

The U.V.T.A. Manager Visa
Dr. Massimo Castoro

Exhibit 1:	Surgical instruments description
Exhibit 2:	Electron microscopy report
Exhibit 3:	MELTRON® GG Sodium bicarbonate safety data sheet
Exhibit 4:	MELTRON® FX Sodium bicarbonate safety data sheet
Exhibit 5:	MELTRON® Food Grade Analysis/Certification
Exhibit 6:	Compact cabin technical data sheet
Exhibit 7:	Air compressor Technical Drawing
Exhibit 8:	Air compressor user handbook
Exhibit 9:	Compressed air consumption table
Exhibit 10:	Studies carried out at the University of Trento, Materials Engineering Department and Industrial Technologies

Exhibit 1:

Bur ID	Use	Notes	Types	Use date	Cleaning date
O1	Otosurgery	Diamond coated	E5220 2 MM	10/02/2012	14/02/2012
O2	Otosurgery	Finned	E8230 LSO 3 MM	10/02/2012	14/02/2012
O3	Otosurgery	Diamond coated	E5230 3 MM	10/02/2012	14/02/2012
O4	Otosurgery	Finned	E8065 LSO 6,5 MM	10/02/2012	14/02/2012
O5	Otosurgery	Diamond coated	E5210 1 MM	10/02/2012	14/02/2012
O6	Otosurgery	Diamond coated	E5130 6 MM	14/02/2012	15/02/2012
O7	Otosurgery	Diamond coated	E5050 5 MM	14/02/2012	15/02/2012
O8	Otosurgery	Diamond coated	E6220 2 MM	14/02/2012	15/02/2012
O9	Otosurgery	Finned	E8005LSO 6,5 MM	14/02/2012	15/02/2012
O10	Otosurgery	Finned	E8230 LSO 3 MM	15/02/2012	22/02/2012
O11	Otosurgery	Finned	E8240 LSO 4 MM	15/02/2012	22/02/2012
O12	Otosurgery	Diamond coated	E5230 3 MM	15/02/2012	17/02/2012
O13	Otosurgery	Diamond coated	E5220 2 MM	15/02/2012	22/02/2012
O14	Otosurgery	Diamond coated	E6215 1,5 MM	15/02/2012	22/02/2012
O15	Otosurgery	Diamond coated	E6207 0,7 MM	15/02/2012	17/02/2012
O16	Otosurgery	Diamond coated	E5210 1 MM	15/02/2012	17/02/2012
O17	Otosurgery	Finned	E8065 LSO 6,5 MM	21/02/2012	22/02/2012
O18	Otosurgery	Diamond coated	E5130 6 MM	21/02/2012	22/02/2012
O19	Otosurgery	Diamond coated	E5210 1 MM	21/02/2012	22/02/2012
O20	Otosurgery	Diamond coated	E5220 2 MM	21/02/2012	22/02/2012
O21	Otosurgery	Finned	E8230 LSO 3 MM	09/02/2012	23/02/2012
O22	Otosurgery	Diamond coated	E5220 2 MM	09/02/2012	23/02/2012
O23	Otosurgery	Diamond coated	E5220 2 MM	24/02/2012	27/02/2012
O24	Otosurgery	Finned	E8250 LSO 5 MM	24/02/2012	27/02/2012
OL 1	Otosurgery	Diamond coated	E6220 2 MM	16/02/2012	16/02/2012
OL2	Otosurgery	Finned	E8065 LSO 6,5 MM	16/02/2012	16/02/2012
OL3	Otosurgery	Diamond coated	E6220 2 MM	16/02/2012	16/02/2012
OL4	Otosurgery	Diamond coated	E6220 2 MM	16/02/2012	16/02/2012
OL5	Otosurgery	Finned	E8040LSO 4 MM	16/02/2012	16/02/2012
OL6	Otosurgery	Finned	E8050LSO 5 MM	16/02/2012	16/02/2012
OL7	Otosurgery	Finned	E8050LSO 5 MM	15/02/2012	17/02/2012
OL8	Otosurgery	Diamond coated	E6160 6 MM	15/02/2012	17/02/2012
OL9	Otosurgery	Finned	E8040LSO 4 MM	15/02/2012	22/02/2012
N1	Neurosurgery	Finned	GE504R 2,3 MM	10/02/2012	14/02/2012
N2	Neurosurgery	Finned	GE504R 2,3 MM	13/02/2012	14/02/2012
N3	Neurosurgery	Finned	GE507R 4 MM	13/02/2012	14/02/2012
N4	Neurosurgery	Diamond coated	GE417R 4 MM	14/02/2012	15/02/2012
N5	Neurosurgery	Finned	GE407R 4 MM	14/02/2012	15/02/2012
N6	Neurosurgery	Craniotome	GE520R	16/02/2012	16/02/2012
N7	Neurosurgery	Craniotome	GE520 R	21/02/2012	22/02/2012
N8	Neurosurgery	Craniotome	GE520 R	21/02/2012	22/02/2012
N9	Neurosurgery	Craniotome	GE520 R	22/02/2012	22/02/2012
N10	Neurosurgery	Craniotome	GE520R	24/02/2012	27/02/2012
D1	Day-surgery	Linvatec		13/02/2012	14/02/2012
D2	Day-surgery	Linvatec		13/02/2012	14/02/2012
D3	Day-surgery	Linvatec		14/02/2012	15/02/2012
D4	Day-surgery	Linvatec		14/02/2012	15/02/2012

**N9 Craniotome already cleaned using standard enzymatic bath and brushing*

Exhibit 2:

REGIONE VENETO
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Responsabile Prof. Marialuisa Valente
c/o ex Istituto di Anatomia Patologica
Via A. Gabelli 61 - 35121 PADOVA - Tel 049-821.3043 049-821.1641 - Fax 049-821.1642
e.mail aip.clopd@sanita.padova.it

NUMERO ESAME : **12-S-0001** TIPO ESAME : **Sem**
DATA ACCETTAZIONE : 21/03/2012 DATA DIAGNOSI : 22/05/2012

Campione **FRESA ROSETTA E8240 LSO 4 MM**

Materiale
Fresa rosetta

Provenienza: Unità Interaziendale valutazione beni e tecnologie sanitarie

Notizie cliniche
Fresa rosetta utilizzata.

DIAGNOSI
Fresa rosetta la cui superficie presenta depositi di tessuto osseo (Fig. 2A-C).
Sigle MV /

Patologo Referente
Prof.ssa M. Valente

Il Direttore
Prof. Marialuisa Valente

Fig. 2 Fresa rosetta E8240 LSO 4 MM utilizzata

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NUMERO ESAME : **12-S-0002** TIPO ESAME : **Sem**
DATA ACCETTAZIONE : 21/03/2012 DATA DIAGNOSI : 22/05/2012

Campione **FRESA ROSETTA PM E8240 LSO 4 MM**

Materiale
Fresa rosetta

Provenienza: Unità Interaziendale valutazione beni e tecnologie sanitarie

Notizie cliniche
Fresa rosetta utilizzata e successivamente sottoposta a pulizia meccanica.

DIAGNOSI
Fresa rosetta utilizzata e pulita meccanicamente con superficie prevalentemente liscia e occasionali, minuti depositi di fosfato di calcio (Fig 3A,B).
Sigle MV /

Patologo Referente
Prof.ssa M. Valente

Il Direttore
Prof. Marialuisa Valente

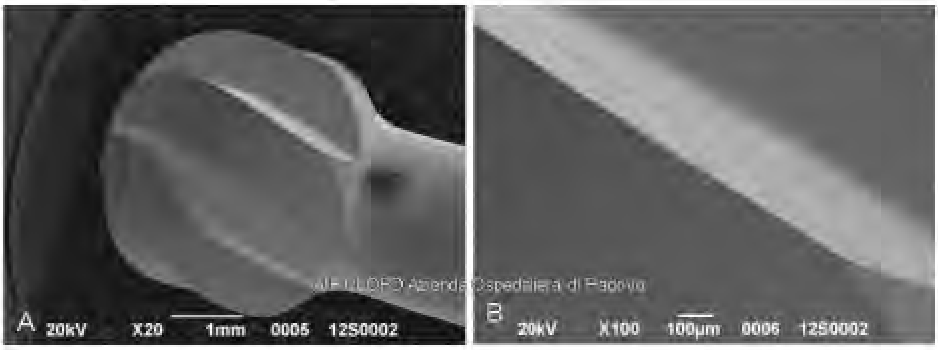

Fig. 3 Fresa Rosetta E8240 LSO 4 MM utilizzata e poi sottoposta a pulizia meccanica

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NUMERO ESAME : **12-S-0003** TIPO ESAME : **Sem**
DATA ACCETTAZIONE : 21/03/2012 DATA DIAGNOSI : 22/05/2012

Campione **CRANIOTOMO GE520R**

Materiale
Craniotomo

Provenienza: Unità Interaziendale valutazione beni e tecnologie sanitarie

Notizie cliniche
Craniotomo utilizzato.

DIAGNOSI
Craniotomo la cui superficie presenta depositi di tessuto osseo (Fig. 6A-C).
Sigle MV /

Patologo Referente
Prof.ssa M. Valente

Il Direttore
Prof. Marialuisa Valente

Fig. 6 Craniotomo GE520R utilizzato

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e.mail aip.clopd@sanita.padova.it

NUMERO ESAME : **12-S-0004** TIPO ESAME : **Sem**
DATA ACCETTAZIONE : 21/03/2012 DATA DIAGNOSI : 22/05/2012

Campione **CRANIOTOMO PM GE520R**

Materiale
Craniotomo

Provenienza: Unità Interaziendale valutazione beni e tecnologie sanitarie

Notizie cliniche
Craniotomo utilizzato e successivamente sottoposto a pulizia meccanica.

DIAGNOSI
Craniotomo utilizzato e pulito meccanicamente con superficie prevalentemente liscia e occasionali, minuti depositi di fosfato di calcio
(Fig 7A, B).
Sigle MV /

Patologo Referente
Prof.ssa M. Valente

Il Direttore
Prof. Marialuisa Valente

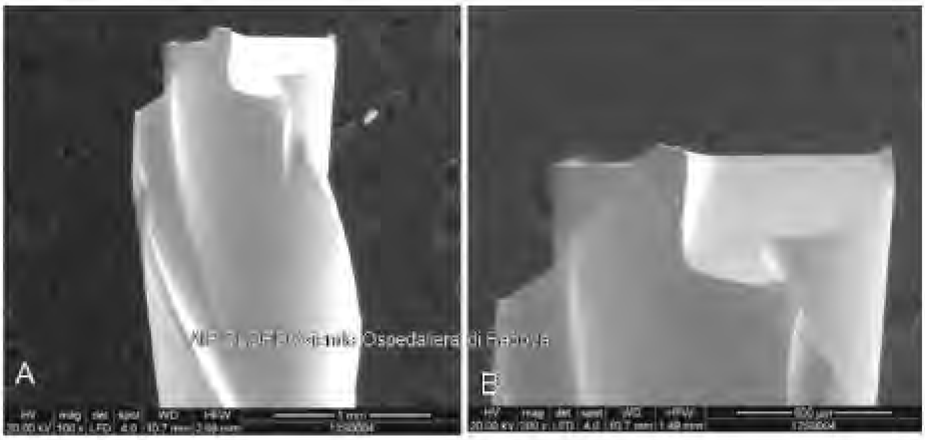

Fig. 7 Craniotomo GE520R
utilizzato e poi sottoposto a pulizia meccanica

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NUMERO ESAME : **12-S-0005**
DATA ACCETTAZIONE : 21/03/2012

TIPO ESAME : **Sem**
DATA DIAGNOSI : 22/05/2012

Campione **CRANIOTOMO GE520R**

Materiale
Craniotomo

Provenienza: Unità Interaziendale valutazione beni e tecnologie sanitarie

Notizie cliniche
Craniotomo nuovo.

DIAGNOSI
Craniotomo intatto, dalla superficie liscia, con margini ben definiti (Fig. 1).
Sigle MV /

Patologo Referente
Prof.ssa M. Valente

Il Direttore
Prof. Marialuisa Valente

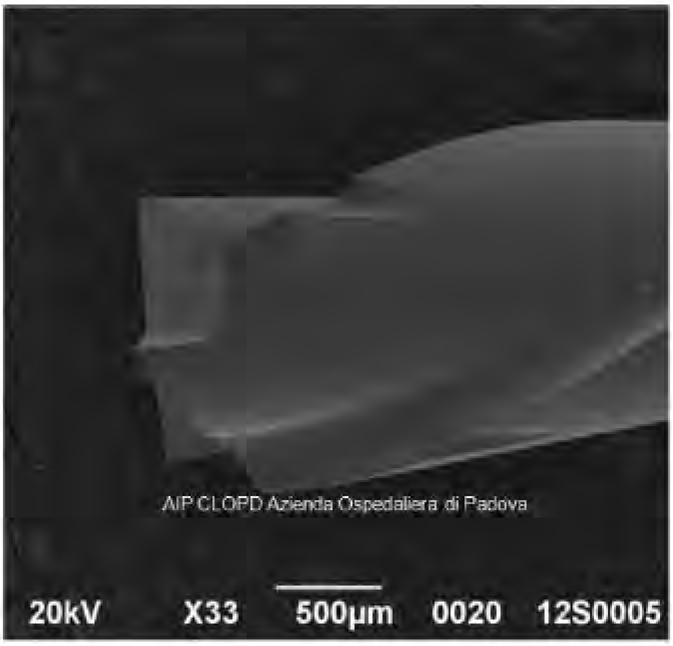

Fig.1 Craniotomo GE520 (nuovo)

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NUMERO ESAME : **12-S-0006** TIPO ESAME : **Sem**
DATA ACCETTAZIONE : 21/03/2012 DATA DIAGNOSI : 22/05/2012

Campione **FRESA DIAMANTATA E5220 2 MM**

Materiale
Fresa Diamantata

Provenienza: Unità Interaziendale valutazione beni e tecnologie sanitarie

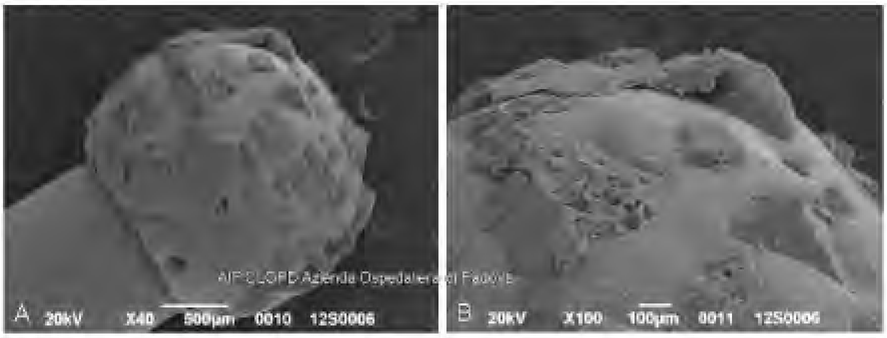
Notizie cliniche
Fresa diamantata utilizzata.

DIAGNOSI

Fresa diamantata la cui superficie presenta depositi di tessuto osseo (Fig. 4A-C).
Sigle MV /

Patologo Referente
Prof.ssa M. Valente

Il Direttore
Prof. Marialuisa Valente



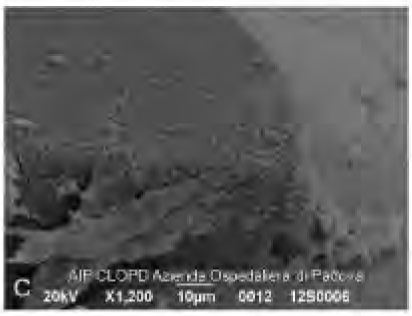


Fig. 4 Fresa Diamantata E5220 2 MM utilizzata

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e.mail aip.clopd@sanita.padova.it

NUMERO ESAME : **12-S-0006**
DATA ACCETTAZIONE : 21/03/2012

TIPO ESAME : **Sem**
DATA DIAGNOSI : 22/05/2012

Campione **FRESA DIAMANTATA E5220 2 MM**

Materiale
Fresa Diamantata

Provenienza: Unità Interaziendale valutazione beni e tecnologie sanitarie

Notizie cliniche
Fresa diamantata utilizzata.

DIAGNOSI
Fresa diamantata la cui superficie presenta depositi di tessuto osseo (Fig. 4A-C).
Sigle MV /

Patologo Referente
Prof.ssa M. Valente

Il Direttore
Prof. Marialuisa Valente

Fig. 4 Fresa Diamantata E5220 2 MM utilizzata

Exhibit 3:

BICAR*jet*®

BICARJET S.r.l.
Via Nona Strada, 4 – PADOVA (PD) - 35129 Italy
Tel. +39 049 7808036 – Fax. +39 049 7927203

SAFETY DATA SHEET

(according to Directive 2001/58/CE)

MELTRON®

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

1.1. Identification of the substance or preparation

Product name:	MELTRON®
Chemical name:	Sodium hydrogencarbonate
Synonym(s):	Sodium bicarbonate
Formula:	$NaHCO_3$
Molecular weight:	84,02
EC Number (EINECS):	205-633-8

1.2. Company/undertaking identification

Legal and operative headquarter:

BICARJET S.r.l.
Via Nona Strada, 4
35129 Padova – Italy

Tel. +39.049.7808036
Fax +39.049.7927203
E-mail: info@bicarjet.com

1.3. Urgency telephone: Tel. 39 0586 721111

2. COMPOSITION/INFORMATION ON INGREDIENTS

Sodium bicarbonate

CAS Number:	144-55-8
EC Number (EINECS):	205-633-8

3. HAZARDS IDENTIFICATION

- Substance non classified according to Directive 67/548/EEC

4. FIRST-AID MEASURES

4.1. Inhalation

- Remove the subject from dusty environment and let him blow his nose.

4.2. Eyes contact

- Flush eyes with running water for several minutes, while keeping the eyelids wide open.
- Consult with an ophthalmologist in case of persistent pain.

4.1. Skin contact

- Negligible

4.2. Ingestion

General recommendations

- Negligible

If the subject is completely conscious:

- Rinse mouth with fresh water.

If the subject is unconscious:

- Not applicable

5. FIRE-FIGHTING MEASURES

5.1. Suitable extinguishing media

- In case of fire in close proximity, all means of extinguishing are acceptable (subject to section below).

5.2. Unsuitable extinguishing media

- No restriction.

5.3. Special exposure hazards

- Non-combustible

5.4. Protective measures in case of intervention

- The product does not require any special precautions.

5.5. Other precautions

- Negligible

6. ACCIDENTAL RELEASE MEASURES

6.1. Personal precautions

- Follow the protective measures given in section 8.

6.2. Environmental precautions

- Prevent discharges into the environment (sewers, rivers, soils...).
- Prevent any mixture with an acid into the sewer/drain (gas formations).

6.3. Methods for cleaning up

- Collect the product with suitable means avoiding dust formation.
- Place everything into a closed, labelled container compatible with the product.
- For disposal methods, refer to section 13.
- Clean the area with large quantities of water.

7. HANDLING AND STORAGE

7.1. Handling

Keep away from reactive products (see section 10).

7.2. Storage

Keep away from reactive products (see section 10).

7.3. Specific use(s)

For any particularly use, please contact the supplier.

7.4. Packaging

PE

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

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8.1. Exposure limit values

Sodium bicarbonate
TLV (ACGIH-USA)
Result: Negligible

8.2. Exposure controls

- Premises ventilation.
- Provide local ventilation suitable for the emission risk.

8.2.1. Occupational exposure controls

8.2.1.1. Respiratory protection

- In case of dust clouds/fog/fumes, dust mask type P1.

8.2.1.2. Hand protection

- Protective gloves - for frequent or prolonged operations:

8.2.1.3. Eye protection

- Dust proof goggles, if dusty.

8.2.1.4. Skin protection

- Negligible

8.2.1.5. Other precautions

- Negligible

8.2.2. Environmental exposure controls

- Respect local/federal and national regulations for aqueous emissions (see section 15).

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1. General information
Appearance: crystalline powder
Color/Colour: white
Odor/Odour: odorless/odouless

9.2. Important health, safety and environmental information

pH:	8,6 (*Concentration*: 5 %)
Boiling point:	Non applicable (Decomposition).
Flash point:	Non applicable.
Flammability:	Non flammable.
Explosive properties:	Non explosive
Oxidising properties:	Non oxidizer
Vapor/Vapour pressure:	Non applicable.
Density:	
Specific gravity:	2,22
Bulk density:	from 0,5 - 1,2 kg/dm3
Solubility:	Water 96 g/l
Temperature:	20 °C
Another	Very slightly soluble in alcohol
Coefficient de partage n-octanol/water:	Non applicable.
Viscosity:	1,2 mPa.s
Vapor/Vapour density (air=1):	Non applicable.

9.3. Other information

Melting point/range:	Non applicable (Decomposition).
Auto-flammability:	Non-flammable.
Decomposition temperature:	> 60 °C.

10. STABILITY AND REACTIVITY

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10.1. Conditions to avoid

- Heating the product to its decomposition temperature (see section 9).

10.2. Materials to avoid

- Acids

10.3. Hazardous decomposition products

- Negligible

11. TOXICOLOGICAL INFORMATION

1.1. Toxicological data

Acute toxicity

- Oral route, LD 50, rat, > 2 g/kg
- Inhalation, LC 50, no data
- Dermal route, LD 50, no data

Irritation

- Rabbit, slightly irritant (skin)
- Rabbit, slightly irritant (eyes)

Sensitisation

- No data

Chronic toxicity

- no observed effect
- In vitro, no mutagenic effect
- Oral route (gavage), 10 days, various species, 330 mg/kg, No teratogenic effect

Comments

- No appreciable toxic effect

1.2. Health effects

Inhalation

- Slight nose irritation.

Eyes contact

- Moderate irritation.

Skin contact

- Negligible

Ingestion

- By ingestion of large quantities: nausea and vomiting.

12. ECOLOGICAL INFORMATION

12.1. Ecotoxicity

Acute ecotoxicity

- Fishes, Oncorhynchus mykiss, LC 50, 96 h, 7.700 mg/l
- Fishes, Oncorhynchus mykiss, NOEC, 96 h, 2.300 mg/l
- Fishes, Lepomis macrochirus, LC 50, 96 h, 7.100 mg/l
- Fishes, Lepomis macrochirus, NOEC, 96 h, 5.200 mg/l
- Crustaceans, Daphnia magna, EC 50, 48 h, 4.100 mg/l
- Crustaceans, Daphnia magna, NOEC, 48 h, 3.100 mg/l

12.2. Mobility

- Water : considerable solubility and mobility
- Soil/sediments : considerable solubility and mobility

12.3. Persistance et degradability

Abiotic degradation

- Water, hydrolysis: acid/base equilibrium as a function of pH

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- Degradation's products: carbonic acid/carbon dioxide (pH < 6) / bicarbonate (pH 6 - 10) / carbonate (pH > 10)

Biotic degradation
- Résult: non applicable

12.4. Bioaccumulative potential
- Résult: non bioaccumulable

12.5. Other adverse effects
- Study in progress

12.6. Comments
- Product is not significantly hazardous for the environment.

13. DISPOSAL CONSIDERATIONS

13.1. Waste treatment
- Dispose in compliance with local/federal and national regulations.
- Contact waste exchanges for recycling.

Or
- Dissolve in water.
- Neutralise the product with an acid.

13.2. Packaging treatment
- To avoid treatments, as far as possible, use dedicated containers.

If not,
- Rinse the empty containers with plenty of water and treat the effluent in the same way as waste.

Or
- Dispose of the containers by dispatching them to an approved industrial incineration facility.
- The empty and clean containers are to be reused in conformity with regulations.

14. TRANSPORT INFORMATION

- Not subject

15. REGULATORY INFORMATION

15.1. EC Labelling

Not classified according to Directive 67/548/EEC.

16. OTHER INFORMATION

16.1. Reason for update
- Update:
- sections 9 – 16

This MSDS is intended for only the selected countries to which it is applicable. For example, this MSDS is not intended for use nor distribution within North America. You should contact Solvay America company representative for the official North America MSDS.
The given information corresponds to the current state of our knowledge and experience of the product, and is not exhaustive. This applies to product which conforms to the specification, unless otherwise stated. In this case of combinations and mixtures one must make sure that no new dangers can arise. In any case, the user is not exempt from observing all legal, administrative and regulatory procedures relating to the product, personal hygiene, and protection of human welfare and the environment.

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Exhibit 4:

MELTRON® GG

Blast media

Product description

Inorganic mineral synthetic salt
Crystalline, white odorless powder

CAS number	144-55-8
EC numbre (EINECS)	205-633-8
ID number (Annex I)	-
EC classification	-
Chemical formula	$NaHCO_3$
Molecular weight	84
Moh hardness	2,5 – 3

Chemical and physical properties

		Typical values	*Analysis method*
Total alkalinity, expressed in $NaHCO_3$		> 98%	Internal - BR AN 10 A/035
Sodium	Na	$\geq$ 27%	Internal - BR AN 10 A/030
Calcium	Ca	$\leq$ 100 ppm	Internal - BR AN 10 A/030
Iron	Fe	$\leq$ 5 ppm	Internal - BR AN 10 A/039
Magnesium	Mg	$\leq$ 50 ppm	Internal - BR AN 10 A/030
Chlorides	Cl	$\leq$ 50 ppm	Internal - BR AN 10 A/030
Density in Kg/dm^3		2,218	
pH (solution 5 g/100 ml)		< 8,6	
Solubility in water a 20°C in g/1000 g (endotermic)		96	
Solubility in alcohol		Insolubile	
Free flowing density in Kg/dm^3		0,90 - 1,30	

Manufactured without any organic solvents
Does not contain any allergens

Granulometry cumulative values

		Analysis method
< 500 µm	$\geq$ 90%	Internal - BR AN 10 A/035
< 250 µm	$\leq$ 20%	
< 160 µm	$\leq$ 1,5%	

Packaging and storage

25 kg PE bags
Store in a dry and cool place

Note

Please read Safety Data Sheet of the substance

MELTRON® is a product not classified as dangerous according to Directive 67/548/EEC

This product is not exposed to regulations regarding transport of dangerous material (ADR-RID)

Date	01/2006	Version	01

BICAR jet

Operatons headquarter :
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Web site: www.bicarjet.com - E-mail: info@bicarjet.com

Exhibit 5:

A.R.P.A.V.

AGENZIA REGIONALE PER LA PREVENZIONE E PROTEZIONE AMBIENTALE DEL VENETO

DIPARTIMENTO PROVINCIALE DI BELLUNO

SERVIZIO LABORATORI

Struttura responsabile:
"Laboratorio di Chimica Alimenti"

Rapporto di Prova

n.4934/1

Campione di "Meltron- sodio bicarbonato per la pulizia di superfici" in conf. da 25 Kg prodotto per Bicarjet Srl-Via Varesina, 2/4-Angera (VA)

****

Caratteri organolettici : prodotto salino, di colore bianco, inodore.

Contenitore originale integro in polietilene.

Saggio per il sodio		: positivo
Saggio per il carbonato		: positivo
Ammoniaca (per riscaldamento)		: non rilevabile
Sostanze insolubili (1 g su 20 ml acqua)		: assenti
Perdita all'essicazione (gel di silice 4 h)	%	: 0.007
Tenore (in $NaHCO_3$), titrimetrico)	%	: 99.60
Cloruro di sodio (dal Cl presente-CI)	%	: 0.01
Ferro (a.a.)	mg/Kg	: 2.8
Arsenico (a.a.)	mg/Kg	< 0.08
Piombo (a.a.)	mg/Kg	< 0.1
Mercurio (a.a.)	mg/Kg	< 0.1
Metalli totali (come Pb)	mg/Kg	< 0.05

CONCLUSIONI : In base alle determinazioni effettuate, il prodotto analizzato si giudica chimicamente equivalente al bicarbonato di sodio (E 500 ii) per uso alimentare (D.M. 27/2/96 n.209 all.XVII per Italia e CE) e conforme alle specifiche del Food Chemicals Codex 5^{th} Ed.(2003) pg 405 previste dalla FDA degli USA per bicarbonato di sodio come "sostanza generalmente riconosciuta come sicura" per uso alimentare.

Belluno, 15/10/04

IL CHIMICO DIRIGENTE
(Dr.B.Agnech)

/bz

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Exhibit 6:

®

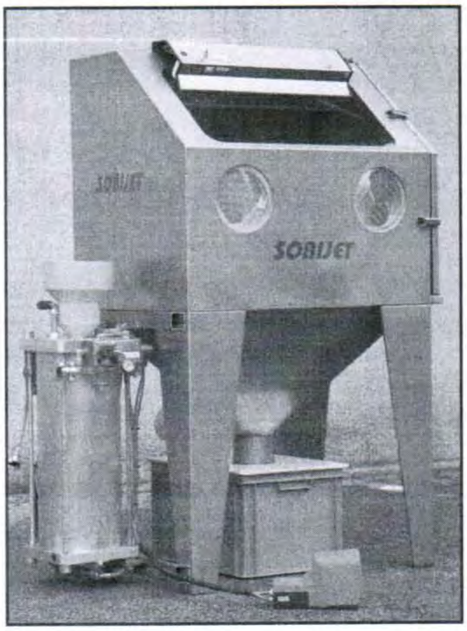
Compact cleaning system

Easy-to-use and versatile **SOBIJET**® delivery unit for environmental-friendly surface cleaning based on compressed air, water and MELTRON® - a specific grade of sodium bicarbonate*.

Thanks to the MELTRON® features and the simplicity of the system, the operator can work in completely safe and efficient conditions with a minimum training.

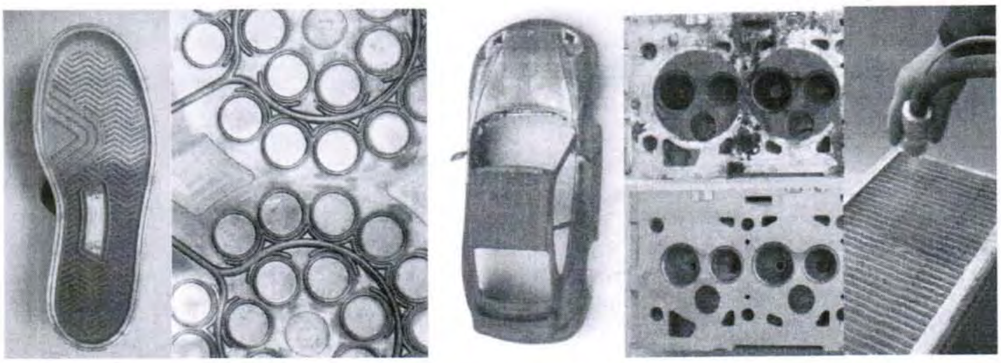
The **COMPACT 900** delivery unit is made of a cabin in stainless steel and a feeding unit **MIDI 125** , very easy and versatile to use, completely safe according to the EEC standards.

This compact system has been expressly studied for the cleaning of delicate objects of small dimensions with respect to the operators and the environment.



Suitable for the following applications:

- Cleaning of moulds and delicate surfaces
- Cleaning of mechanical parts and motors
- Depainting and removing of contaminants



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SOBIJET® COMPACT 900

Features of the system

Made of INOX AISI 304 stainless sheet-steel with big thickness and lateral charging door with hooks closing and a window with tempered safety glass equipped with pneumatic windscreen-wiper and external light. The working place is equipped with latex gloves, working hose with nozzle and hydrojet pistol for rinsing the part with air/water. Under the discharging hopper there is a collecting vessel for the exhausted material*.
The system is connected to a feeding unit controlled by a pneumatic foot remote control, made of a pressure tank conform to PED-EC standards, TÜV branded, with manual regulating valve for the MELTRON® consumption, exercise pressure regulator and pneumatic pump for water*.
A suction system with single-phase electric motor and screw body with open blade fan is available separately from the cabin. A flexible tube assures the connection from the cabin to the cyclone dust filter in polythene folded paper.

Dimensions

- Max. external dimensions	1300 x 770 x 1660 mm
- External cabin dimensions	900 x 695 x 750 mm
- Max. available dimensions	600 x 350 x 400 mm
- Max. loading charge	50 Kg
- Total net weight of the system	123 Kg

Features

- MELTRON® tank capacity	25 lt.
- Compressed air feeding line	½" – 15 mm
- Max pressure of dried and filtered air	8 bar
- Working hose	25 x 13 mm
- Applicable nozzles	6 – 7 – 8 mm
- Water feeding line*	¼" – 8 mm
- Max water pressure*	3 bar
- Collecting basin capacity*	80 lt.
- Diameter of discharging water output*	32 mm
- Light	220 Volts - 50 Hz
Suction	
- Motor	220 Volts – 50 Hz – monophase
- Capacity	400 mc/h – 100 mm H_2O
- Cartrige of the cyclone filter	14 sqm

Consumptions (according to adjustments)

- Dried and filtered compressed air	from 0,5 to 5 m3/min.
- Water*	from 1 to 2 lt./min.
- MELTRON®	from 0,3 to 1,5 Kg./min.
- Light	20 W
- Suction unit	0,250 Kw

** available only in the "COMPACT 900W" wet version*

Data	01/2008	Version	01

BICAR jet

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Exhibit 7:

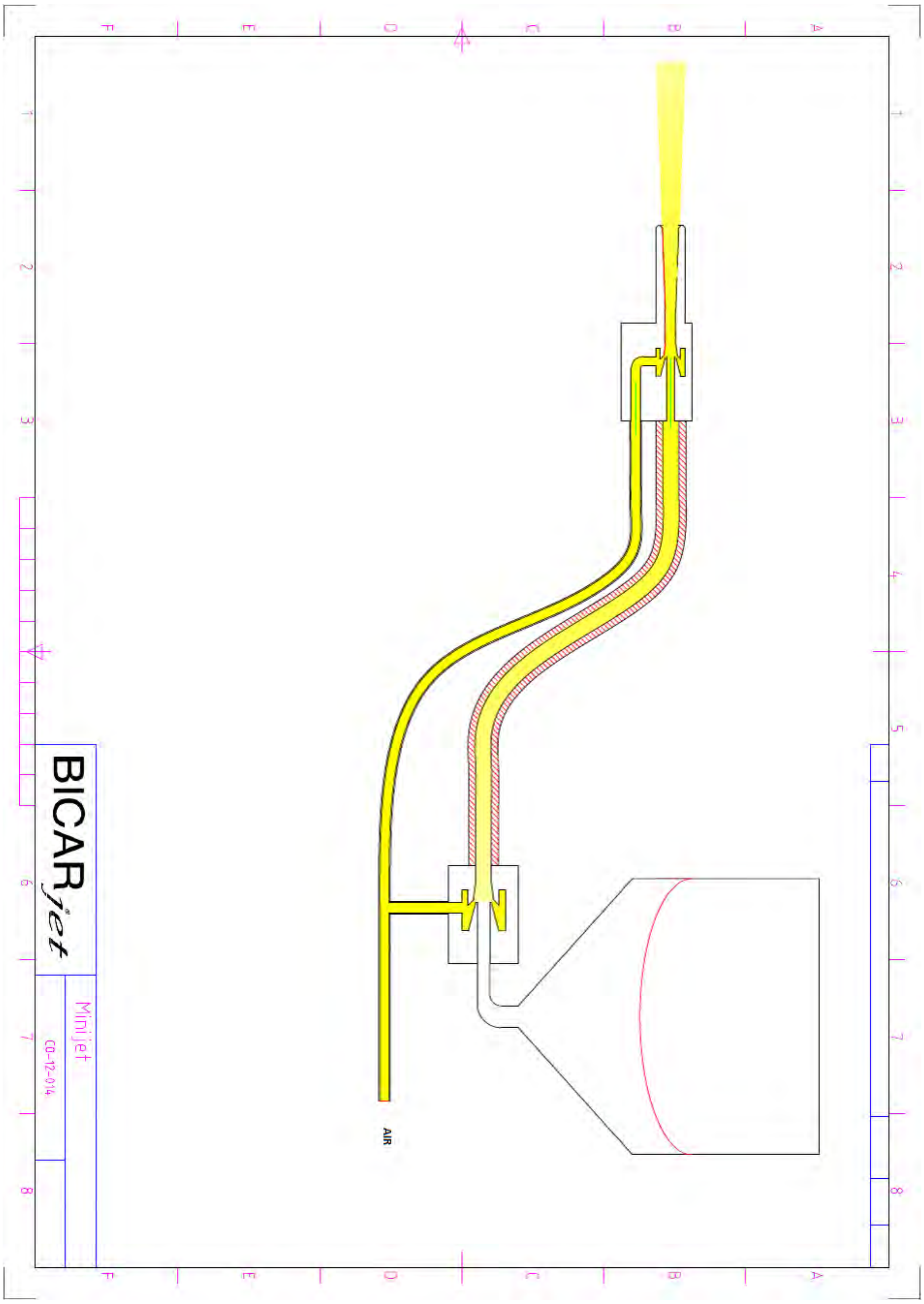

Exhibit 8:

Preserve this handbook for future reference

GB

1 PRECAUTIONS

The ACOUSTIC PRESSURE's value measured at 4 m in free field corresponds to the ACOUSTIC POWER's value stated on the yellow label located on the compressor, minus 20 dB.

⚠ THINGS TO DO

- **The compressor must be used in a suitable environment (well ventilated with an ambient temperature of between +5°C and +40°C) and never in places affected by dust, acids, vapors, explosive or flammable gases.**
- Always maintain a safety distance of at least 4 meters between the compressor and the work area.
- Any coloring of the belt guards of the compressor during painting operations indicates that the distance is too short.
- Insert the plug of the electric cable in a socket of suitable shape, voltage and frequency complying with current regulations.
- For 3-phase versions, have the plug fitted by a qualified electrician according to local regulations. When starting the compressor for the first time, check the correct direction of rotation and that this matches the direction indicated by the arrow on the belt guard (versions with plastic protection) or on the motor (versions with metal protection).
- Use extension cables with a maximum length of 5 meters and of suitable cross-section.
- The use of extension cables of different length and also of adapters and multiple sockets should be avoided.
- Always use the switch of the pressure switch to switch off the compressor or use the switch of the electric panel for models equipped with this. Never switch off the compressor by pulling out the plug in order to avoid restart with pressure in the head.
- Always use the handle to move the compressor.
- When operating, the compressor must be placed on a stable, horizontal surface to guarantee correct lubrication.
- Position the compressor at least 50 cm from the wall to permit optimal circulation of fresh air and to guarantee correct cooling.

⚠ THINGS NOT TO DO

- Never direct the jet of air towards persons, animals or your body. (Always wear safety goggles to protect your eyes from flying objects that may be lifted by the jet).
- Never direct the jet of liquids sprayed by tools connected to the compressor towards the compressor.
- Never use the appliance in your bare feet or with wet hands or feet.
- Never pull the power cable to pull the plug out of the socket or to move the compressor.
- Never leave the appliance exposed to adverse weather conditions (rain, sun, fog, snow).
- Never transport the compressor with the reservoir pressurized
- Never weld or machine the reservoir. In the case of faults or corrosion, replace it completely.
- Never allow inexpert persons to use the compressor. Keep children and animals away from the work area.
- Never position flammable or nylon or fabric articles close to and/or on the compressor.
- Never clean the compressor with flammable liquids or solvents. Clean with a damp cloth only, after making sure that you have unplugged the compressor.
- The compressor is designed only to compress air and must not be used for any other type of gas.
- The compressed air produced by the compressor cannot not be used for pharmaceutical, food or hospital purposes except after particular treatments. It is not suitable for filling the air bottles of scuba divers.
- Never use the compressor without guards (belt guard) and never touch moving parts.

⚠ THINGS YOU SHOULD KNOW

- **To avoid overheating of the electric motor, this compressor is designed for intermittent operation as indicated on the dataplate** (for example, S3-50 means 5 minutes ON and 5 minutes OFF). In the case of overheating, the thermal cutout of the motor trips, automatically cutting off the power when the temperature is too high due to excess current take-off.
- **To facilitate machine restart, it is important not only to carry out the operations indicated but also to set the button of the pressure switch, returning this to the OFF position and then ON again (figures 1a-1b).**
- On single-phase versions, press the reset button on the terminal box of the motor (**fig. 2**).
- On 3-phase versions, operate manually on the button of the pressure switch, returning this to the ON position, or press the button of the thermal cutout inside the box of the electric panel (**figures 3a-3b-3c**).
- The single-phase versions are fitted with a pressure switch equipped with a delayed closing air vent valve (or with a valve located on the check valve) that facilitates motor start-up; therefore a few-second jet of air from this, with the reservoir empty, is to be considered normal.
- To guarantee machine safety, all the compressors are fitted with a safety valve that is activated in the case of failure of the pressure switch (**fig. 4**).
- All two-stage compressors are equipped with safety valves on the air delivery manifold to the reservoir and on the connection hose between the low and high pressure located on the head. These are activated in the case of malfunctioning (**fig. 5**).
- When connecting an air-powered tool to a hose of compressed air supplied by the compressor, interruption of the flow of air from the hose is compulsory.
- Use of the compressed air for the various purposes envisaged (inflation, air-powered tools, painting, washing with water-based detergents only, etc.) requires knowledge of and compliance with the rules established for each individual use.

2 START-UP AND USE

- Fit the wheels and foot (or the caster wheel for models that are fitted with this) according to the instructions provided in the packaging. For versions with fixed feet, assemble the front bracket kit or the vibration-dampers if furnished. Check that the rating data match the effective characteristics of the system (voltage and power).
- Check for correspondence between the compressor plate data with the actual specifications of the electrical system. A variation of ± 10% with respect of the rated value is allowed.
- Insert the power plug in a suitable socket checking that the button of the pressure switch located on the compressor is in the "O" (OFF) position (**figures 6a-6b-6c-6d**).
- For the 3-phase versions, connect the plug to a panel protected by suitable fuses.
- For the versions fitted with electric panel ("Tandem" control units or delta/star starters) have installation and connections (to the motor, to the pressure switch and to the electrovalve if any) carried out by qualified personnel.
- Check the oil level using the sight glass and if necessary unscrew the vent plug and top up. (**figures 7a-7b**).
- At this point, the compressor is ready for use.
- Operating on the switch of the pressure switch (or the selector for versions with electric panel, (**figures 6a-6b-6c-6d**), the compressor starts, pumping air in the reservoir through the delivery hose. On 2-stage versions, air is sucked in to the so-called low pressure cylinder liner and precompressed. It is then routed, through the recirculation hose, into the so-called high pressure liner and then into the reservoir. With this work cycle, it is possible to reach higher pressure, with availability of air at 11 bar (15 bar for special machines).
- On reaching maximum operating pressure (factory-set during testing), the compressor stops, venting the excess air present in the head and in the delivery hose through a valve located under the pressure switch (in delta/star versions, through an electrovalve that is activated when the motor stops).
- The absence of pressure in the head facilitates subsequent restart. When air is used, the compressor restarts automatically when the lower calibration value is reached (approx. 2 bar between upper and lower). The pressure inside the reservoir can be checked on the gauge provided (**fig. 4**).
- The compressor continues to operate automatically with this work cycle until the position of the switch of the pressure switch (or of the selector of the electric panel) figures **6a-6b-6c-6d**) is modified. To use the compressor again, wait at least 10 seconds after this has been switched off before restarting.
- In the versions with electric panel, the pressure switch must always be aligned with the I (ON) position.
- In tandem versions, the control unit provided permits use of only one of the two compressor groups (if necessary alternatively) or of both at the same time according to requirements. In this second case, start-up will be differentiated slightly to avoid excessively high current take-off at start-up (timed starting).
- Only the wheel-mounted compressors are fitted with a pressure reducer (in the versions with fixed feet, it is usually installed on the use line). Air

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pressure can be regulated in order to optimize use of air-powered tools operating on the knob with the valve open (pulling it up and turning it in a clockwise direction to increase pressure and counterclockwise to reduce this) (**fig. 8**). Once you have set the value required, push the knob down to lock it.

- The value set can be checked on the gauge (for versions equipped with this, **fig. 9**).
- **Please check that the air consumption and the maximum working pressure of the pneumatic tool to be used are compatible with the pressure set on the pressure regulator and with the amount of air supplied by the compressor.**
- When you have finished working, stop the machine, pull out the plug and empty the reservoir.

3 MAINTENANCE

- The service life of the machine depends on maintenance quality.
- PRIOR TO ANY OPERATION SET THE PRESSURE SWITCH TO THE OFF POSITION, PULL OUT THE PLUG AND COMPLETELY DRAIN THE RESERVOIR.
- Check that all screws (in particular those of the head of the unit) are tightly drawn up (**fig. 10**). The check must be carried out prior to the first compressor starting.

TABLE 1 – TIGHTENING OF HEAD TENSION RODS

	Nm Min. torque	Nm Max. torque
Screw M6	9	11
Screw M8	22	27
Screw M10	45	55
Screw M12	76	93
Screw M14	121	148

- Clean the suction filter according to the type of environment and in any case at least every 100 hours. If necessary, replace the filter (a clogged filter impairs efficiency while an inefficient filter causes harsher wear on the compressor (**figures 11a - 11b**).
- Change the oil after the first 100 hours of operation and subsequently every 300 hours. Check the oil level periodically.
- Use Sae 40 mineral oil. (For cold climates, Sae 20 is recommended). Never mix different grade oils. If the oil changes color (whitish = presence of water; dark = overheated), it is good practice to replace the oil immediately.
- After topping up, tighten the plug (**fig. 12**) making sure that there are no leaks during use. Once a week, check the oil level to assure lubrication in time (**fig. 7a**).
- Periodically (or after completing work if for more than an hour), drain the condensate that forms inside the reservoir due to the humidity in the air (**fig. 13**) in order to protect the reservoir from rust and so as not to restrict its capacity.
- Periodically, check the tension of the belts which must have a flexion (f) of around 1 cm (**fig. 14**).

TABLE 2 – MAINTENANCE

FUNCTION	AFTER THE FIRST 100 HOURS	EVERY 100 HOURS	EVERY 300 HOURS
Cleaning of intake filter and/ or substitution of filtering element		•	
Change of oil*	•		•
Tightening of head tension rods	The check must be carried out prior to the first compressor starting.		
Draining tank condensate	Periodically and at the end of work		
Checking the tension of the belts	Periodically		

* Spent oil and condensate **MUST BE DISPOSED OF** in compliance with protection of the environment and current legislation.

The compressor must be disposed in conformity with the methods provided for by local regulations

4 POSSIBLE FAULTS AND RELATED PERMITTED REMEDIES

Request the assistance of a qualified electrician for operations on electric components (cables, motor, pressure switch, electric panel, etc).

FAULT	CAUSE	REMEDY
Air leak from the valve of the pressure switch.	Check valve does not perform its function correctly due to wear or dirt on the seal.	Unscrew the hex-shaped head of the check valve, clean the housing and the special rubber disk (replace if worn). Re-assembler and tighten carefully (**figures 15a-15b**).
	Condensate drainage cock open.	Close the Condensate drainage cock.
	Rilsan hose not inserted correctly in pressure switch.	Insert the Rilsan hose correctly inside the pressure switch (**fig. 16**).
Reduction of efficiency, frequent start-up. Low pressure values.	Excessively high consumption.	Decrease the demand of compressed air.
	Leaks from joints and/or pipes.	Change gaskets.
	Clogging of the suction filter.	Clean/replace the suction filter (**figures 11a-11b**).
	Slipping of the belt.	Check belt tension (**fig. 14**).
The motor and/or the compressor overheat irregularly.	Insufficient ventilation.	Improve ambient conditions.
	Closing of air ducts.	Check and if necessary clean the air filter.
	Insufficient lubrication.	Top up or change oil (**figures 17a-17b-17c**).
After an attempt to start the compressor, it stops due to tripping of the thermal cutout caused by forcing of the motor.	Start-up with head of the compressor charged.	Release the compressor head by using the pressure switch push button.
	Low temperature.	Improve ambient conditions.
	Voltage too low.	Check that the mains voltage matches that of the dataplate. Eliminate any extensions.

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FAULT	CAUSE	REMEDY
After an attempt to start the compressor, it stops due to tripping of the thermal cutout caused by forcing of the motor.	Incorrect or insufficient lubrication.	Check level, top up and if necessary change the oil.
	Inefficient electrovalve.	Call the Service Center.
During operation, the compressor stops for no apparent reason.	Tripping of the thermal cutout of the motor.	Check level oil.
		Single-stage, mono-phase versions: operate on the button of the pressure switch returning this to the OFF position (**fig. 1a**). Reset the thermal cutout (**fig. 2**) and restart (**figures 1b**). If the fault persists, call the Service Center.
		Versions with delta-star starter: operate on the button of the thermal cutout located inside the box of the electric panel (**fig. 3c**) and restart (**fig. 6d**). If the fault persists, call the Service Center.
		Other versions: Operate on the button of the pressure switch returning this to the OFF position and then to ON again (**fig. 1a-1b**). If the fault persists, call the Service Center.
	Electric fault.	Call the Service Center.
When operating, the compressor vibrates and the motor emits an irregular buzzing sound. If it stops, it does not restart although the sound of the motor is present.	**Single-phase motors:** faulty capacitor.	Have the capacitor replaced.
	3-phase motors: One of the phases of the 3-phase power supply is missing due probably to blowing of a fuse.	Check the fuses inside the electric panel or the electric box and if necessary replace those that have been damaged (**fig. 18**).
Irregular presence of oil in the network.	Too much oil inside the unit.	Check oil level.
	Wear on segments.	Call the Service Center.
Leaking of condensate from the vent cock.	Presence of dirt/grit inside the cock.	Clean the cock.

Any other type of operation must be carried out by authorized Service Centers, requesting original parts. Tampering with the machine may impair its safety and in any case make the warranty null and void.

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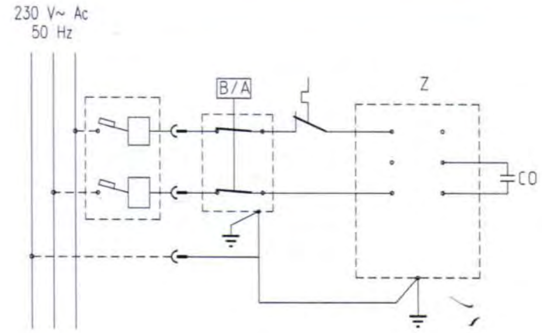

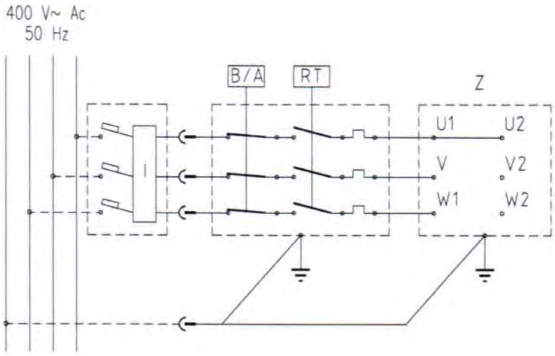

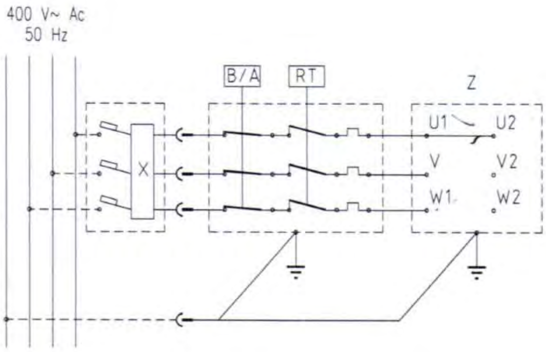

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Exhibit 9:

BICARjet

SISTEMI ECOLOGICI DI PULIZIA DI SUPERFICI CON BICARBONATO DI SODIO
ENVIRONMENTAL FRIENDLY SODIUM BICARBONATE-BASED SURFACE CLEANING SYSTEMS

COMPRESSED AIR CONSUMPTION

litre / min.

Equipments with pressure vessel (conform to PED norm)

Air line	Nozzle *mm*	Compressed air working pressure - *bar*							
		1	2	3	4	5	6	7	8
½" - DN15	6	560	810	1.080	1.350	1.650	1.950	2.200	
½" - DN15	7	670	1.140	1.470	1.810	2.230	2.620	2.780	
½" - DN15	8	700	1.310	1.740	2.210	2.650	2.960	3.250	
1" - DN25	6,5	760	1.090	1.410	1.790	2.150	2.530	2.760	
1" - DN25	8	1.120	1.690	2.190	2.700	3.050	3.450	3.850	
1" - DN25	9,5	1.300	2.000	2.620	3.270	3.650	4.450		
1" - DN25	11	2.000	2.920	3.920	4.730				
1" - DN25	12	2.360	3.350	4.550	4.900				

COMPRESSED AIR CONSUMPTION

litre / min.

Equipments with HPV patented system

Air line	Nozzle *mm*	Compressed air working pressure - *bar*							
		1	2	3	4	5	6	7	8
½" - DN15	5x12	500	700	900	1.100	1.300	1.540	1.750	1.820
½" - DN15	5x13	510	740	950	1.180	1.390	1.630	1.840	1.980
½" - DN15	5x14	520	750	970	1.190	1.400	1.660	1.860	1.990
1" - DN25	7x12	600	850	1.070	1.280	1.530	1.750	1.990	2.070
1" - DN25	7x13	610	890	1.120	1.350	1.610	1.860	2.100	2.200
1" - DN25	7x14	620	900	1.130	1.360	1.620	1.870	2.110	2.210

BICARjet s.r.l.
Sede Commerciale / Operation Office:
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Partita IVA / VAT code nr: IT03735720280

Exhibit 10:

UNIVERSITA' DEGLI STUDI
DI TRENTO

DIPARTIMENTO DI INGEGNERIA DEI MATERIALI E TECNOLOGIE INDUSTRIALI

FINAL TECHNICAL REPORT

Contract of technical advice between

BICARJET S.r.l.

and

The Department of Materials Engineering and Industrial Technologies of the University of Trento

"Investigation of the roughness and the surface morphology changes after several bicarbonate powder treatments on painted and not painted aluminium samples"

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Report on Bicarjet tests on painted and non painted Aluminium samples

1. Tests propose

The object of the tests has been to investigate the roughness and the surface morphology changes after several bicarbonate powder treatments on painted and not painted aluminium samples.

2. Tests methods

Samples were produced in three production sessions using dry bicarbonate powder of various size. During each production session an aluminium sheet of dimensions 80x60mm was used, the sheet has been divided in 12 areas. The tests were performed treating each area with a different air pressure and times, the other areas were protected by a thick polymeric layer. The distance between the nozzle and the sample was 10 cm and the incidence was perpendicular to the surface.
For every area it was measured the roughness (the parameters were: length 5 mm speed 0.15 mm/s) and was analysed with SEM in order to evaluate the surface morphology changes produced by the treatment.
Table 1 shows the details of the treatments.

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Test Date	Material	Bicarbonate powder size	Area name	Pression (bar)	Time (seconds)
12/03/04	Painted Aluminium	0.130	0	Not treated reference	
			1a	1	22
			1b	1	90
			2a	2	15
			2b	2	10
			3a	3	10
			3b	3	7
			4a	4	9
			4b	4	6
			5a	5	4
			5b	5	2
22/03/04	Painted Aluminium	0.250	0	Not treated reference	
			1a	1	70
			1b	1	35
			2a	2	11
			2b	2	4
			3	3	3
			4	4	3
			5	5	3
29/03/04	Aluminium alloy 2024 T3 Alclad	0.130	0	Not treated reference	
			1a	1	3
			1b	1	30
			2a	2	3
			2b	2	30
			3a	3	3
			3b	3	30
			4a	4	3
			4b	4	30
			5a	5	3
			5b	5	30

Table 1 – *Summary of the performed tests*

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3. *Results*

3.1 Preliminary analysis after sample production

Tests on painted aluminium with a powder size of 0.130 revealed that a pressure of 1 bar was too low to remove the painting even with long treatments time (>90 s). The time necessary to remove the painting with a pressure of 2 and 3 bar were easy to measure, it was respectively 15 s and 10 s. Whit a pressure of 4 and 5 bar the removal rate was very high that it was difficult to define exactly a time of painting remove.

Using a powder size of 0.250 the painting removal rate was higher and with a pressure above 3 bar the removal was immediate.

Due to the increase of roughness, all the treatments on the unpainted 2024 T3 Alclad alloy produced clearly visible spots. Considering a pressure of 4 bar or above and times of 30 seconds the surface had a smoother appearance than the others, it was also clear the step between the treated and untreated area because of the packing of the metal.

3.2 Roughness

Measured Ra values are shown in figures 1-3. They are the mean of at least 4 measurements.

It is clear that considering short treatment times the roughness increases with the pressure. On the other hand with longer times the roughness can decrease because the greater number of impacts with the metallic surface make it flatter.

The difference between treated and untreated aluminium is very high (mire than 1 μm Vs 0.1 μm), nevertheless it is equal or below 2 μm in the greatest part of the tests.

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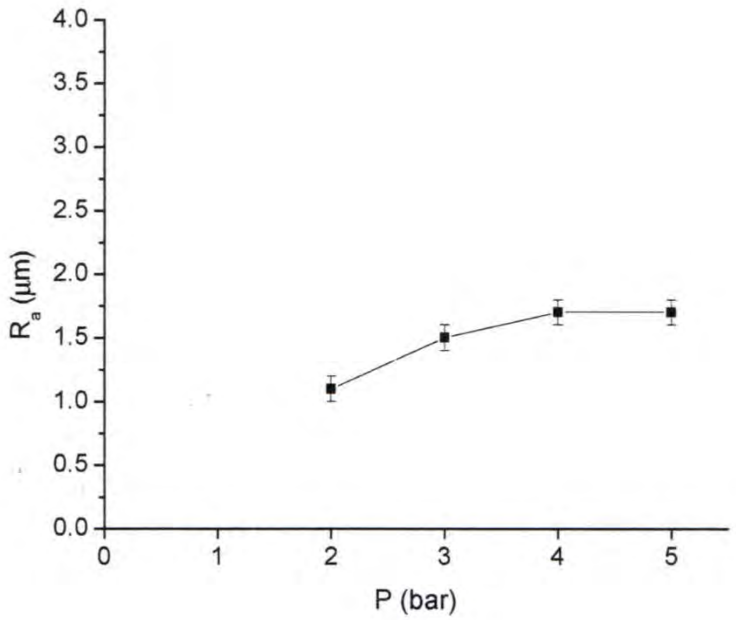

Figure 1 *Ra with various treatment pressure of a painted sample. The powder size was 0.130. The blue point reefers to the untreated aluminium. The points shown refer to areas named 2a, 3a, 4a, 5a.*

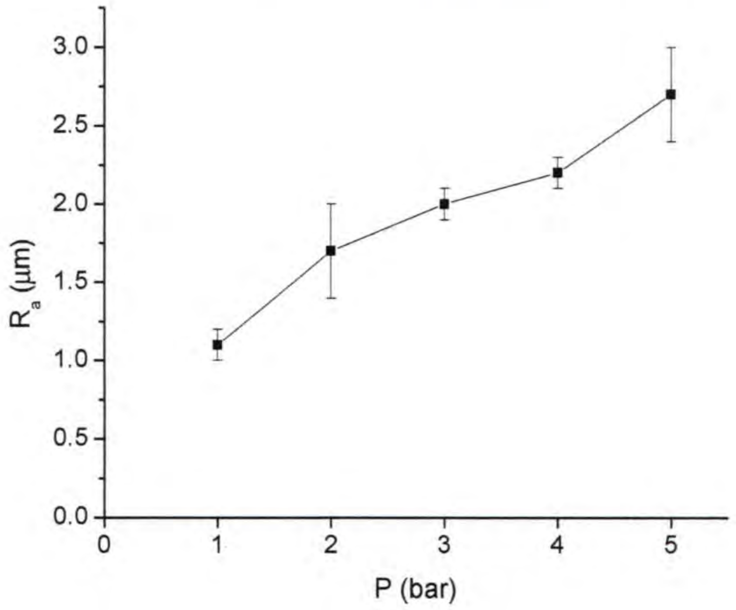

Figure 2 *Ra with various treatment pressure of a painted sample. The powder size was 0.250. The blue point reefers to the untreated aluminium. The points shown refer to areas named 1a, 2a, 3a, 4a, 5a.*

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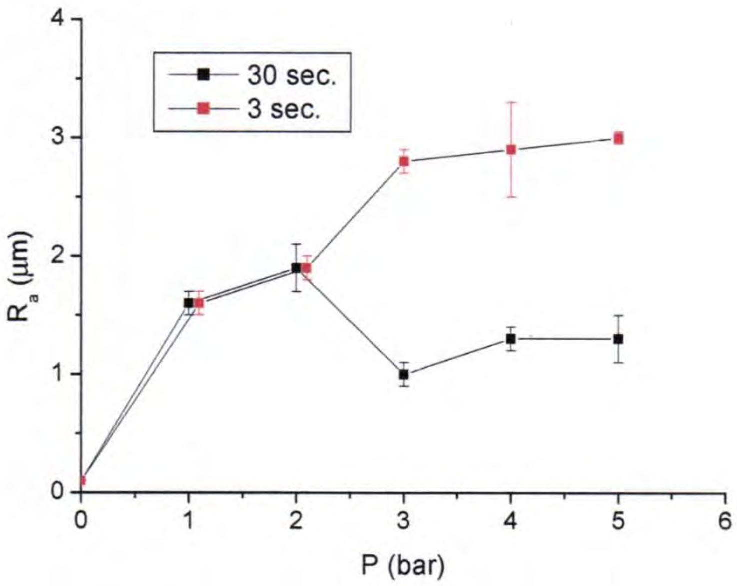

Figure 3 *Ra with various treatment pressure of 2024 T3 Alclad alloy. The powder size was 0.130.*

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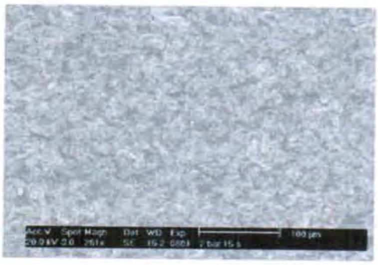
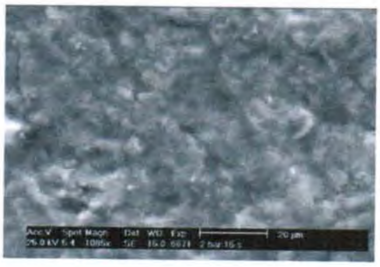
3.3 Analisi SEM

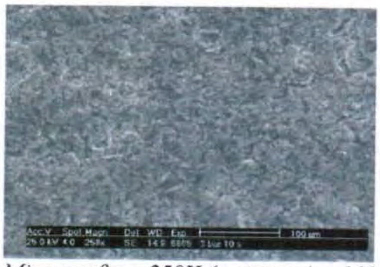
Il quadro completo delle micrografie SEM ottenute sia a 250X che a 1000X viene riportato nelle pagine seguenti

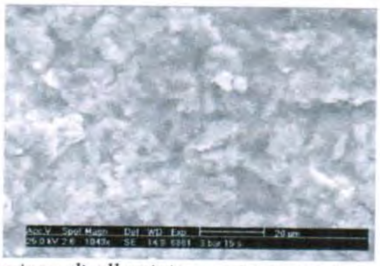
<u>Campione trattato il 12/03/04</u>



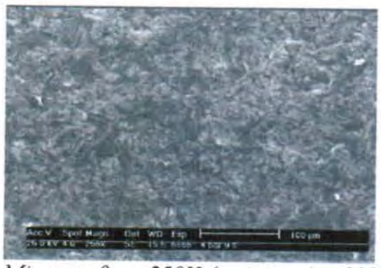


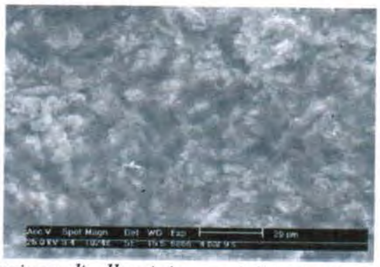
Micrografie a 250X (a sinistra) e 1000X (destra) del campione di alluminio verniciato trattato il 12/03/04, area 2a





Micrografie a 250X (a sinistra) e 1000X (destra) del campione di alluminio verniciato trattato il 12/03/04, area 3a





Micrografie a 250X (a sinistra) e 1000X (destra) del campione di alluminio verniciato trattato il 12/03/04, area 4°

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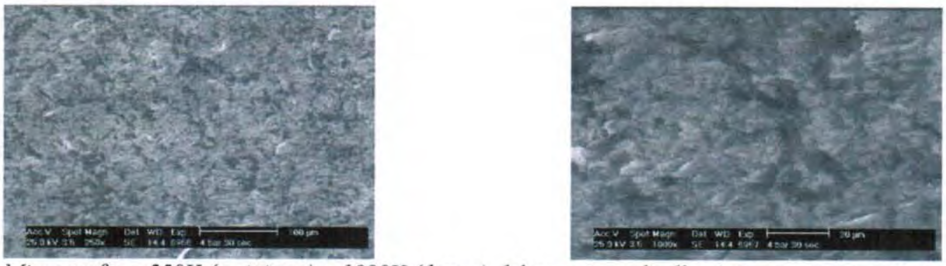
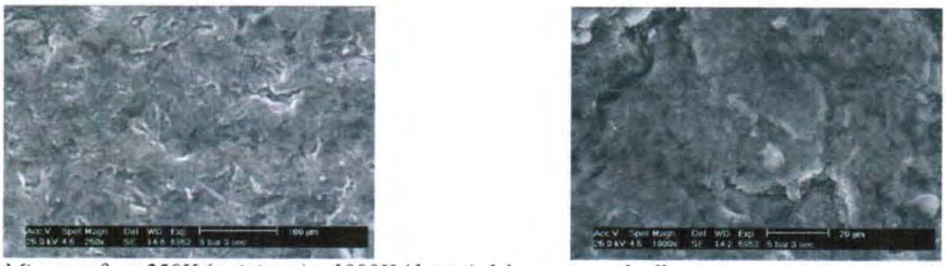
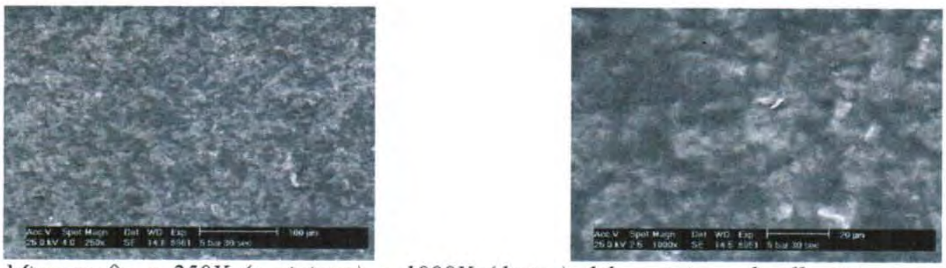
Micrografie a 250X (a sinistra) e 1000X (destra) del campione di alluminio verniciato trattato il 29/03/04, area 4a



Micrografie a 250X (a sinistra) e 1000X (destra) del campione di alluminio verniciato trattato il 29/03/04, area 4b



Micrografie a 250X (a sinistra) e 1000X (destra) del campione di alluminio verniciato trattato il 29/03/04, area 5a



Micrografie a 250X (a sinistra) e 1000X (destra) del campione di alluminio verniciato trattato il 29/03/04, area 5b

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The surface morphology is well correlated to the roughness, in particular it is evident the surface smoothing of 2024 T3 alloy when treated with a pressure of 3 bar or above.

EDAX analysis showed that the painted aluminium is of the 5xxx series because it contains magnesium but not copper. Between the paint and the metal there is a yellow layer rich of chromium and cerium, elements used in the conversion layer.
All the analysed areas have a meaningful quantity of sodium (Al/Na ratio in the range 10-15), the amount of sodium seems to don't depend to the treatment parameters.
The treatment with the powder of size 0.250 left a small but detectable amount of chromium of the conversion layer on the surface. This is probably because the rapid rate of painting removal, giving the appearance of a unpainted surface in short times, doesn't clean completely the metal.
Also the pure aluminium sheets of the 2024 Alclad alloy enriched in sodium while treated in a way not predictable with the process parameters.

4. *Conclusion*

On painted samples it has been defined the process parameters that permit the optimisation of painting removal and a low value of final roughness.
The treatment caused a surface material packing at pressure of 3 bar or above.
On the 2024 T3 Alclad alloy, treatments of 30 seconds allow to maintain the roughness values below 2 μm. On the other side pressures below 3 bar allow to obtain the same range of values even at shorter times.

Prof. Gianantonio Della Mea

Responsabile scientifico del contratto per il
Dipartimento di Ingegneria dei Materiali e Tecnologie Industriali
dell'Università di Trento

UNIVERSITÀ DEGLI STUDI - TRENTO
DIPARTIMENTO DI INGEGNERIA DEI MATERIALI E TECNOLOGIE INDUSTRIALI

UNIVERSITA' DEGLI STUDI
DI TRENTO

DIPARTIMENTO DI INGEGNERIA DEI MATERIALI E TECNOLOGIE INDUSTRIALI

FINAL TECHNICAL REPORT

Contract of technical advice between

BICARJET srl

and

Dipartimento di Ingegneria dei Materiali e Tecnologie Industriali dell'Università di Trento

Corrosion behavior of aluminum alloy 2024 Alclad in presence of Sodium Bicarbonate, in granular dry form and in saturated solution of water, according to the method specified ASTM F 1110-02

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REPORT ON TESTS ON ALUMINIUM CORROSION USING BICARBONATE POWDERS

Test propose

The object of the tests has been to investigate the corrosion behavior of aluminum alloy 2024 Alclad in presence of Sodium Bicarbonate, in granular dry form and in saturated solution of water, according to the method specified ASTM F 1110-02.

Sample preparation

Samples of dimensions of 100 x 50 mm were cut from a 2024 Alclad aluminum alloy sheet. They were cleaned with acetone to remove organic contamination and then washed with deionized water (conducibility 0.2 μS/cm).

The size of Bicarbonate, supplied from Bicarjet was below 130 μm.

Test method

Table 1 reports the description of the treatments .

Sample identification	Treatment composition
1	Deionized water, reference
2	Deionized water, reference
3	Dry granular Sodium Bicarbonate
4	Dry granular Sodium Bicarbonate
5	Dry granular Sodium Bicarbonate
6	Saturated solution of Sodium Bicarbonate
7	Saturated solution of Sodium Bicarbonate
8	Saturated solution of Sodium Bicarbonate
9	Dry granular Sodium Bicarbonate + 2% wt Sodium Phosphate
10	Dry granular Sodium Bicarbonate + 2% wt Sodium Phosphate
11	Saturated solution of Sodium Bicarbonate + 2% wt Sodium Phosphate
12	Saturated solution of Sodium Bicarbonate + 2% wt Sodium Phosphate

Table 1 *List of samples and treatment composition*

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Test method is reported on the standard ASTM F 1110-02.

Test started in a humidity cabinet at 38°C and 95% relative humidity monday evening and ended the successive monday evening after the treatment in ventilated oven at 38°C.

The treated samples were washed in warm water and then in deionized water in an ultrasonic bath.

The visual inspection was done by naked eye and with a low magnification (10X) optical microscope.

Roughness measurements were at least 6 for every sample. The measurements were done only in the discolored or corroded areas. The measured length was 2 mm with and the speed was 0.05 mm/sec. Then the samples, one for each group of treatments were analyzed with a Scanning Electron Microscope.

Results

The relative corrosion severity rating was evaluated visually and is shown in the following table.

Samples	**Treatment composition**	**Surface modification**	**Corrosion severity rating according to ASTM F 1110-02**
1, 2	Deionized water	No modifications	0
3, 4, 5	Dry granular Sodium Bicarbonate	Discoloration in a large area, slight corrosion on 50% of treated area	1 to 2
6, 7, 8	Saturated solution of Sodium Bicarbonate	Discoloration in a large area, corrosion traces	1 to 2
9, 10	Dry granular Sodium Bicarbonate + 2% wt Sodium Phosphate	Discoloration in a large area, slight corrosion on 50% of treated area	1 to 2
11, 12	Saturated solution of Sodium Bicarbonate + 2% wt Sodium Phosphate	Very slight discoloration	1

Table 2 *List of the relative corrosion severity rating for each.*

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Roughness

Average values and Standard Deviations of the measured roughness are reported in Table 3.

Sample	Ra (µm)	Std. Dev.
2	0.13	0.02
3	2.49	0.37
4	2.28	0.42
5	2.37	1.61
6	0.43	0.15
7	0.43	0.10
8	0.43	0.22
9	1.04	0.39
10	1.21	0.28
11	0.20	0.05
12	0.18	0.03

Table 3 *List of roughness for each sample.*

The roughness of the spicement treated in deionized water is equal to the roughness of non treated aluminum and is caused by the cladding.

The treatment with dry granular Sodium Bicarbonate, alone or with Sodium Phosphate, increases the roughness to values of 1-2 microns. On the other hand saturated solutions give a roughness just over to that of the non treated aluminum.

In general the treatments with Phosphate reduce the roughness.

Scanning Electron Microscope Analysis

Figure 1 *Surface micrography of sample 2*

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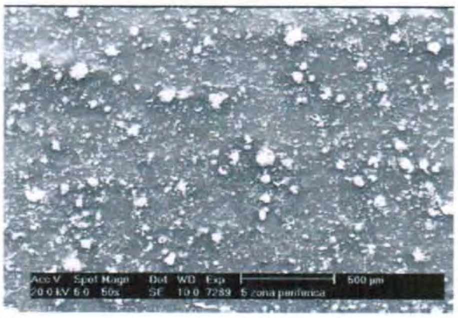

Figure 2 *Surface micrography of sample 5*

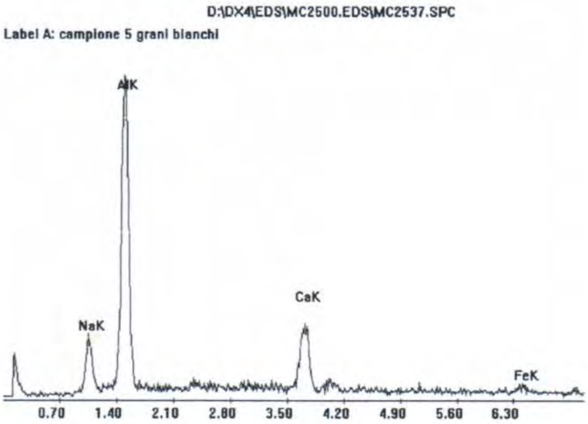

Figure 3 *EDX spectra of a grain visible in Figure 2. The peaks of Sodium and calcium are clear. The peak of aluminum is mainly due to the material surrounding an under the grain.*

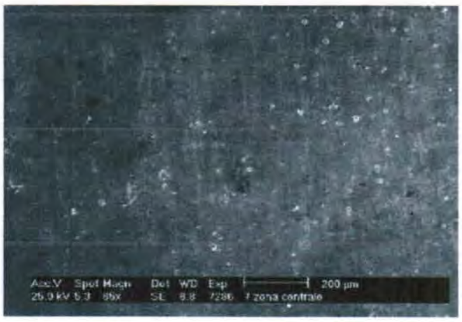

Figure 4 *Surface micrography of sample 7*

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Figure 5 *Detail of the surface of sample 7*

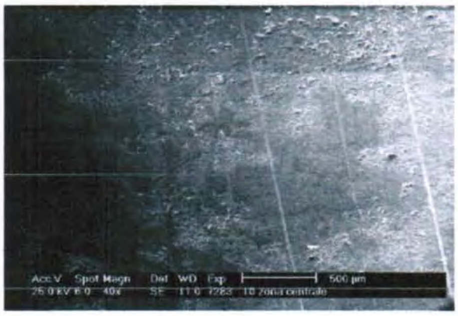

Figure 6 *Surface micrography of sample 10*

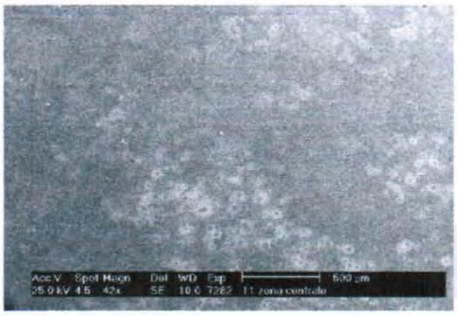

Figure 7 *Surface micrography of sample 11*

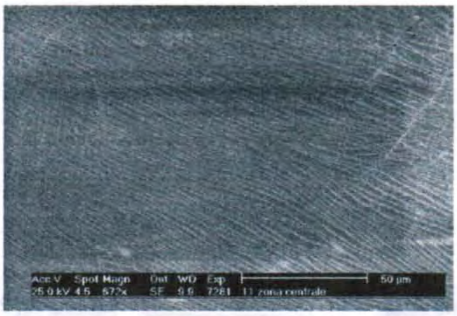

Figure 8 detail of the surface of sample 11

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Samples treated with dry Sodium bicarbonato (Figure 2 and 6) have a surface with a lot of grains and spots with a low electrical conductivity. EDX analysis of these structures indicates that they are rich of Sodium and Calcium (Figure 4), they probably are Bicarbonate grain bonded to the aluminum surface and not removed by the washings after the treatment. The samples treated with saturated solutions the grains are still present but in a very small number (Figure 4 and 7)

The surface between the grains is smooth but high magnifications (600X) reveals a lot of very small cracks (Figure 5 and 8), these cracks are not present in the aluminium treated with deionized water. (Figure 1).

Conclusion

The treatments modiy the aluminum surface in similar but note qual manner.

Saturated solutions give a dicoloration and a sligh corrosion and a small increase of roughness. These effects are less important for the solution with the Sodium Phosphate.

Granular dry products give a greater dicoloration and a sligh corrosion . The surface is less smooth and with a lot of Bicarbonate grains that increase the measured roughness.

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dell'Università di Trento

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UNIVERSITA' DEGLI STUDI
DI TRENTO

DIPARTIMENTO DI INGEGNERIA DEI MATERIALI E TECNOLOGIE INDUSTRIALI

FINAL REPORT

On the consultation contract between

TU.RO.CO. Srl in Padova
and
The Department of Materials Engineering
in the University of Trento

Analysis of the metal surface cleaning process using bicarbonate of soda saturated solution, containing dispersions of solid bicarbonate of soda.

September 2000

1) Choice of the materials:

In co-operation with the Technical experts of TU.RO.CO srl, the materials were identified which were interesting to use for the analysis and the methods were agreed for supplying the samples to be studied.

N° 8 samples of steel of varying hardness
N° 2 samples of aluminium of varying hardness and surface finish

STEEL	Vickers HARDNESS
C45	196 HV
C45 milled	196 HV
2312	287 HV
2312 milled	287 HV
HARDENED AND TEMPERED	296 HV
IMPAX	311 HV
ORVAR	489 HV
STAVAX	556 HV

ALUMINIUM	Vickers HARDNESS
Die AL (supplied by TUROCO)	130 HV
AL ERGAL55 polished (supplied by TRENTO)	185 HV

2) Treatments

As shown in detail in the table below, the samples underwent surface cleaning treatment using the SOBIJET® method, with one of the machines manufactured by TU.RO.CO. S.r.l.
The jet pressure varied during treatment between 0.5 and 5 bar.
The treatment times varied between 15 and 60 seconds (just one test was performed at 240 seconds on die AL).
A constant distance was maintained for all treatments of 7cm.
The treatments were all performed with the jet perpendicular to the sample. Tests were performed at 45° on the AL ERGAL polished sample.
The bicarbonate granulometry was kept constant at 400 micron (just one test was performed with bicarbonate at app. 300 micron on the AL ERGAL polished sample).

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Treatment table (pressures and times)

SAMPLES	PRESSURE (bar)	TIME (seconds)
C45	1 3 5	15 15 15
C45 milled	1 3 5	15 15 15
2312	1 3 5	15 15 15
2312 milled	1 3 5	15 15 15
HARDENED & TEMPERED	1 2 3	15, 30 15, 30 15, 30
IMPAX	1 2 3	15, 30 15, 30 15, 30
ORVAR	1 2 3	15, 30 15, 30 15, 30
STAVAX	1 2 3	15, 30 15, 30 15, 30
Die AL	1 3 5	15, 60 15, 60, 240 15, 60
AL ERGAL55 polished (1° test)	1 3	15, 60 15
AL ERGAL55 polished (2° test)	0,5 1 1,5 3	15 15 15 60
AL ERGAL55 polished (3° test) Inclination 45°	1 3 3 (bicarbonate F)	15 15, 60 15

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ANALYSIS OF THE RESULTS

The prepared samples (refer to the previous table) underwent analysis as given in the technical appendix with the contract.
The following values were measured:

- Vickers hardness before and after treatment - Wolfort hardometer
- X-ray diffraction (micro-structural analysis) - Rigaku Geigerflex diffractometer
- Roughness before and after treatment - Hommel Tester T8000-Hommelwerke GMHB and Tecnor mod. Alphastep200 profilometers
- Electronic scanning microscopy (morphological analysis) – Philips microscope XL30
- Atomic force microscopy (morphological analysis) – AFM Burleigh mod. Vista
- Weight drop during treatment - Scales sensitive to 10^{-6} grams

Vickers hardness was measured before treatment and the results are given in the sample presentation table (refer to page 1).
Hardness was also measured after treatment and no significant changes were registered.
This initial result gives a first indication that SOBIJET® treatment affects and changes the analysed metals for thicknesses of just a few micrometers.
The X-ray diffraction levels before and after treatment showed no variations, confirming the superficial change that was after quantified by the morphological measurements.

Three or four roughness measurements were made on each sample and the results are shown in the appendix.
The appendix also gives the average values of the roughness values on the basis of treatment pressure and time.

Comparison of these results allows us to make a synthesis and draw conclusions.

Fig. 1 shows the average values of roughness variation after the various treatments on all the samples, on the basis of hardness.
It can be noted that ***on samples with hardness above 250 HV with pressures up to 5 bar, no appreciable variations were found in roughness.***
For hardness values below 250 HV, there is no general rule and the type of material, pressure and treatment time must all be taken into account.
We can also note that C45 steel with hardness below 200 HV, not showing any difference between the treatments at various pressures, behaves like steel with greater hardness.
The aluminium samples behave completely differently.
Both the ***samples of aluminium, showed the same behaviour:***
for pressure above 1 bar, the roughness variations increased drastically (refer also to Fig. 2) while for pressures of 1 bar or below, the behaviour was the same as for steel.

The fact that materials with the same hardness (C45 steel and Ergal55 Aluminium) behave differently, shows that ***the material hardness parameter is not the only one to be taken into consideration, but also ductility***.
Ductility of the various types of aluminium is notably higher than that of steel.

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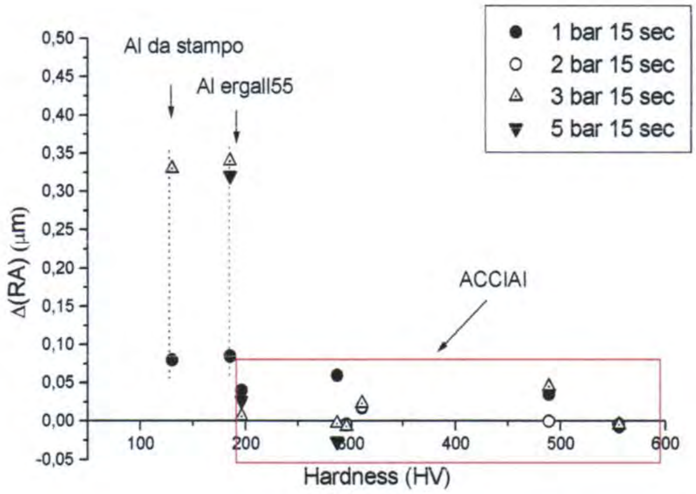

FIG. 1 - Variation in surface roughness of all the samples on the basis of their hardness

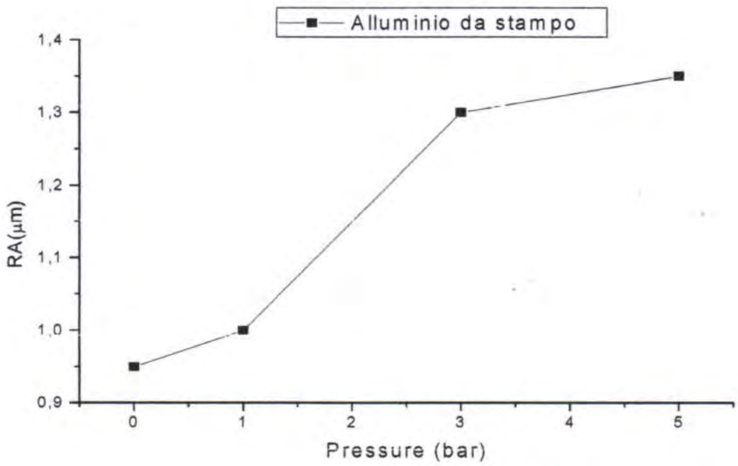

FIG. 2 - Variation of the surface roughness of AL die samples on the basis of the jet pressure

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Fig. 3 shows the roughness variation of all the treated samples at 1 bar pressure for 15 seconds, on the basis of their hardness.
It was noted that for less hard materials (different aluminium samples) the roughness variation was very small, and therefore we can claim that:
for treatments with pressure at around 1 bar on low hardness materials with elevated ductility, the initial roughness is not notably changed.
The general effect why SOBIJET process, involving just the surface part of the samples, does not change initial surface roughness, is confirmed by the electronic scanning microscopic analysis (SEM) and atomic force microscope (AFM) (refer to the appendix).

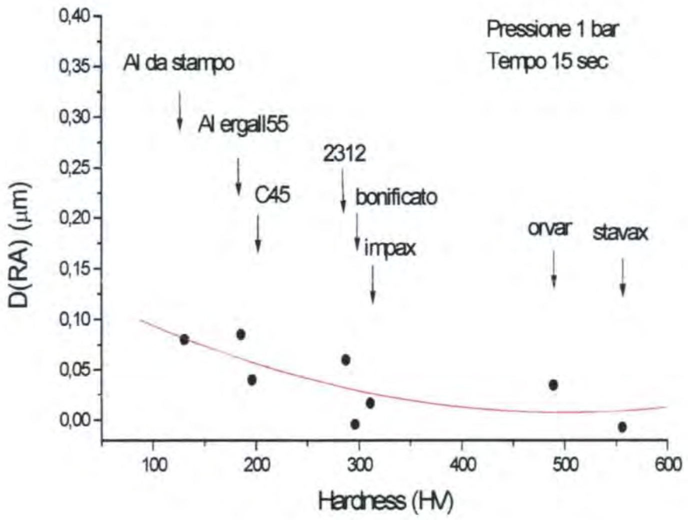

FIG. 3 - Variations of surface roughness of all the samples, on the basis of their hardness for jet pressure treatment at 1 bar for 15 seconds.

On the basis of these results, the different behaviour is evident between the samples of steel and aluminium in the sense that aluminium is easier to damage at pressures between 1 and 3 bar. We must clarify if the greater damage is accompanied by a weight loss caused by removal of surface material.
Two tests were performed, the details are listed in the appendix, with final polishing to less than a micrometer for each test, 4 samples of AL ERGAL55 and then treatment with pressures between 1 and 3 bar for different lengths of time. Special care was paid to washing and drying the samples to ensure no deposit or impurities were left.
The results have shown how the variations in weight (where they exist) are to the millionth of a gram.

Therefore we can claim that the cleaning process does not remove material from the surface, and any unevenness (in the order of micrometers) that can be found in less hard and ductile materials, is caused by the first layers of the sample compacting.

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The same results were obtained treating a series of 4 polished samples of AL ERGAL55 at pressures between 0.5 and 3 bar, for different lengths of time and a 45° jet.

The results (given in the appendix) show that, using sensitive scales to the millionth of a gram, there was no significant removal of material even if roughness gradually increased for treatments at increasing pressure between 1 and 3 bar, thus confirming the data obtained previously (refer to table B) with the values remaining considerably lower than a micrometer.

Measurements on samples of AL ERGAL55 polished and treated at 3 bar for different lengths of time (15 and 60 seconds) showed that with time roughness did not increase, confirming the result obtained with die aluminium treated at 3 bar for 15, 60 and 240 seconds, according to which roughness remained constant as time increased (refer to FIG. 4 and Table A).

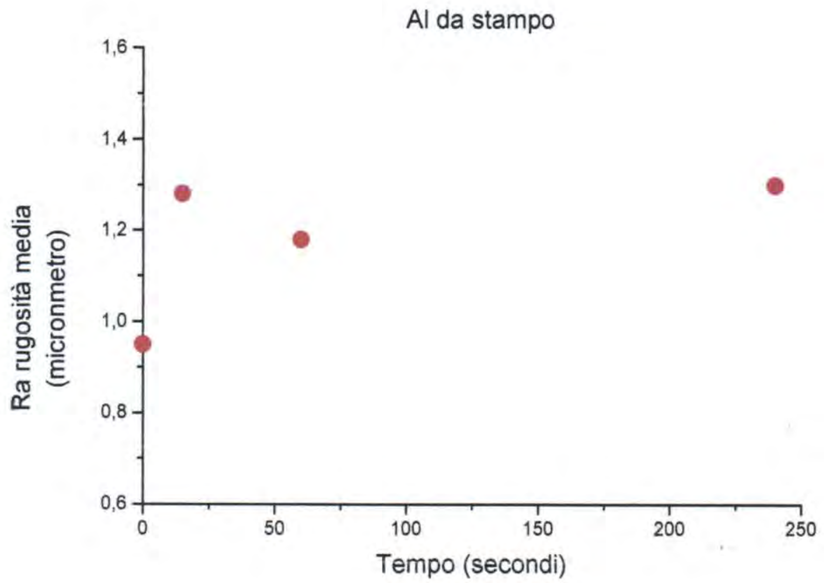

FIG. 4 - Average surface roughness on die aluminium samples, after cleaning with jet pressure at 3 bar on the basis of the time of treatment

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Die AL	Average roughness
Initial conditions	0.95 micrometers
P=3 bar, T=15 sec	1.28 micrometers
P=3 bar, T=60 sec	1.18 micrometers
P=3 bar, T=240 sec	1.30 micrometers

Table A

Another consideration should be made about the limited roughness levels that were measured (a few micrometers: refer to the following table) with reference to the size of the bicarbonate particles (400 micrometers). The effect of the SOBIJET process can be compared with processes that tend to make the surface flat, smoothing any bumps that may be caused by unrefined processing.

AL ERGAL55	Roughness - polished area	Roughness - treated area
P=0.5 bar. T=15 sec	0.025 micrometers	0.075 micrometers
P=1 bar. T=15 sec	0.025 micrometers	0.110 micrometers
P=1.5 bar. T=15 sec	0.030 micrometers	0.140 micrometers
P=3 bar. T=60 sec	Insufficient surface available	0.370 micrometers

Table B

The last consideration regards the optic features of the treated surfaces. The measurements taken on AL ERGAL55 mirror polished samples have shown that treatments at 0.5 bar for 15 seconds, already cause a certain opacity and therefore tests must be performed at lower pressure levels to establish the best levels for this treatment.

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CONCLUSIONS

The studies carried out on the selected samples have shown that SOBIJET® treatment involves and changes metals by just a few micrometers of thickness, even at elevated pressure levels.
On samples with hardness above 200-250 Vickers HV with pressure up to 5 bar, no appreciable variations in roughness were registered.
For samples with hardness below 200 Vickers, the behaviour between steel and aluminium samples was different: steel, not very ductile, continued with no real variations in roughness, while aluminium more ductile, modified at pressure above 1 bar.
For pressures of 1 bar or less, the behaviour of the aluminium samples was the same as that of steel, with limited effects on surface roughness, which, in specific cases, became duller.
During cleaning processes, no material is removed. Any variations in evenness are caused by compacting the first layers of the samples. This effect is more evident in materials with low hardiness and high ductility.
Roughness variations are shown in the first seconds of treatment and remain unchanged for prolonged treatments.
A test was performed using bicarbonate with smaller grains and the results showed no significant change in roughness.

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Appendix

Samples of polished AL ERGAL55 (**first test**)

Four samples were taken of Ergal 55 (aluminium) with 185 Vickers hardness, polished to 1 μm

Sample nr. 1: reference sample

Sample nr. 2: 1 bar for 15 sec. at 5/7 cm

Weight before treatment	6.12025 g
Weight after treatment	6.12021 g
Percentage weight change	6.536E-4 %

Sample nr. 3: 1 bar for 60 sec at 5/7 cm

Weight before treatment	6.07645 g
Weight after treatment	6.07608 g
Percentage weight change	6.09E-3 %

Sample nr. 4: 3 bar 15 sec at 5/7 cm

Weight before treatment	6.04112 g
Weight after treatment	6.04094 g
Percentage weight change	2.98E-3 %

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Appendix

Samples of AL ERGAL55 polished (**second test**)

4 samples of Ergal 55 (aluminium) were taken with 185 Vickers hardness, polished to 1 μm.

Sample nr. 1: 0.5 bar for 15 sec at 5/7 cm

weight before treatment	6.07459 g
weight after treatment	6.07459 g
average weight change	0 %

Sample nr. 2: 1 bar for 15 sec. at 5/7 cm

weight before treatment	6.06191 g
weight after treatment	6.06191 g
average weight change	0 %

Sample nr. 3: 1.5 bar for 15 sec at 5/7 cm

weight before treatment	6.11670 g
weight after treatment	6.11670 g
average weight change	0 %

Sample nr. 4: 3 bar for 60 sec at 5/7 cm

weight before treatment	6.03679 g
weight after treatment	6.03593 g
average weight change	14.25E-3 %

The roughness values are given in the REPORT

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Appendix

Samples of AL ERGAL55 polished (**third test**)

4 samples of Ergal 55 (aluminium) were taken with 185 Vickers hardness polished to 1 µm.

Sample nr. 1: 1 bar for 15 sec at 5/7 cm inclination 45° bicarbonate "G".

weight before treatment	6.03197 g
weight after treatment	6.03197 g
average weight change	0 %
initial surface roughness	0.025 µm
treated surface roughness	0.140-0.155 µm (measured in various areas)

Sample nr. 2: 3 bar for 60 sec. at 5/7 cm inclination 45° bicarbonate "G".

weight before treatment	6.07234 g
weight after treatment	6.06911 g
average weight change	53.19E-3 %
initial surface roughness	0.025 µm
treated surface roughness	0.400-0.500 µm (measured in various areas)

Sample nr. 3: 3 bar for 15 sec at 5/7 cm inclination 45° bicarbonate "G".

weight before treatment	6.11144 g
weight after treatment	6.11092 g
average weight change	8.5E-3 %
initial surface roughness	0.025 µm
treated surface roughness	0.400-0.450 µm (measured in various areas)

Sample nr. 4: 3 bar for 15 sec at 5/7 cm inclination 45° bicarbonate "F".

weight before treatment	6.05802 g
weight after treatment	6.05728 g
average weight change	12.2-3 %
initial surface roughness	0.025 µm
treated surface roughness	0.450-0.465 µm (measured in various areas)

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