SURFACE TREATMENTS: TRANSFER TO LOW-TECH INDUSTRY OF TECHNOLOGIES DEVELOPED FOR SUPERCONDUCTING CAVITIES FOR PARTICLE ACCELERATORS

From Experimental fundamental Physics to Technology Transfer through a University Master on "Surface Treatments for Industrial applications"

For the construction of the Linear Accelerator for Ions ALPI at the Legnaro National Laboratories, since 1987 have been developed infrastructures, laboratories and experiments for the study of technologies such as:

- **superconductivity** (contrary to what happens in normal metals, the electric conduction at low temperatures occurs without energy dissipation);
- **ultra-high vacuum** (since some decades vacuum has forcefully entered into industrial technology. On the other hand, "all that works in air, has, under vacuum, better performances");
- plasma study (a plasma is a layer of the matter composed of ionized particles, thicker than a gas of non-interactive particles, but certainly less thick than any liquid);
- PVD - Thin film deposition techniques (it is possible to interface the coating hardness properties with those of toughness and low-cost substrate, as happens in industry for the coating through cathodic arc of cut tools/implements);
- Chemical and electrochemical polishing of surfaces (during fabrication any mechanical component after shearing, mintage, micro-fusion or pressure die-casting is normally debarred mechanically. Anyway, for some advanced materials mechanical operations may be difficult and expensive, while electrolytic cleaning can give better results at lower costs).

In figure 1 is shown the cleaning phase of a superconducting cavity for ALPI: from rough to internal mirror finishing after immersion in acid baths.

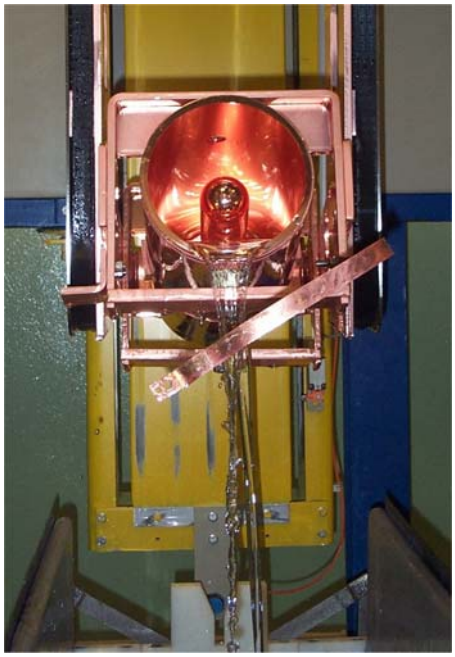

Fig. 1 – Shows an example of surface electrochemical polishing for particle accelerator application

In the framework of an international comparison and competitiveness with the best German, American and Japanese national laboratories, the development of the above mentioned technologies has carried out not only the local construction of the 50 cavities necessary for ALPI, but also, in a wider context as the TESLA Project, the study of a twenty-thousand-cavity particle accelerator, involving more than 40 different institutions from about 20 different countries.

Our cleaning technologies have showed further validity for other INFN applications, such as the studies on the Neutrino physics, and that include the installation underneath the Gransasso Mountain a ultraclean particle detector complex. However, continuous interactions both with foreign and national industry have not given the hoped results. Using commercial baths, the surface contamination at ppb levels instead of decreasing, augmented. It was thus National industry to propose the surface treatments developed at LNL – INFN, as the only possible alternative. In figure 2 is shown the smallest of the treated particle detector after the surface polishing normally applied to cavities.

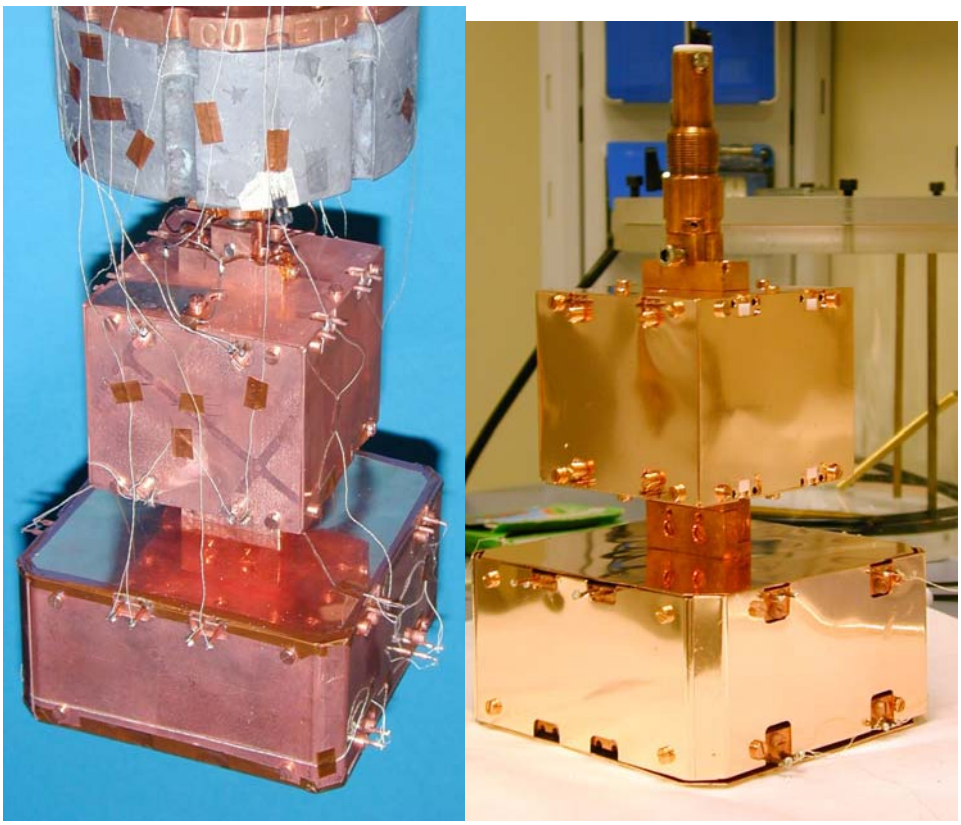

Fig. 2 – Particle Detector before and after chemical treatment

It is evident that the most advanced basic themes in the field of surface treatments are directly applicable to industry. In this sense, the INFN Group V has approved an experiment named BENHUR2 which proposes the transfer of the high-tech technology developed for particle accelerator to the low-tech National Industry sectors which are more interested in technological innovation. Figure 3 shows the most interesting among the results obtained in the industry titanium pivots for dental implantology. Our electrochemistry cleaning technology has been applied to a titanium branemark implant fixture, which can be seen on the left picture after the mechanical forming and on the right picture after just 2-second treatment. The result shown cannot be obtained

with the usual mechanical debarring, moreover by electrochemistry it is possible to treat simultaneously hundreds pieces.

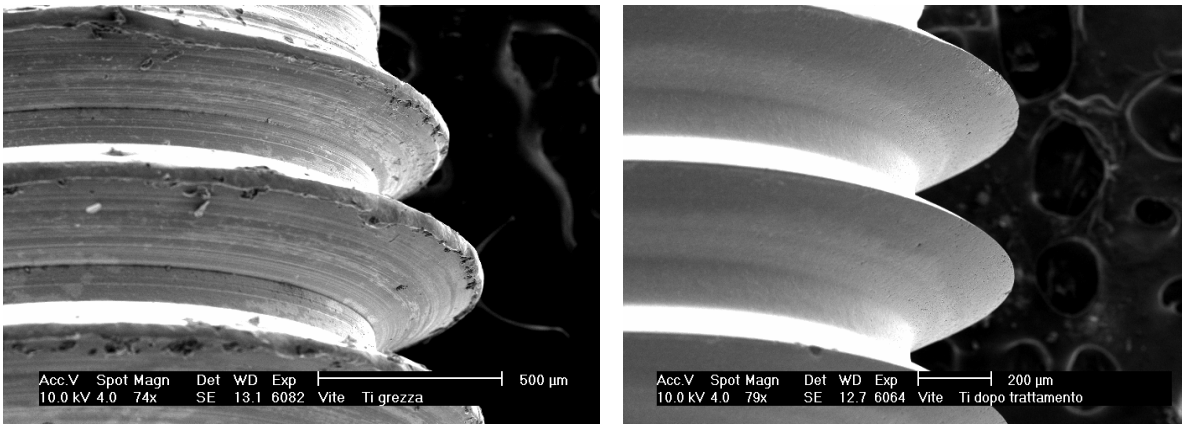

Fig.3- Titanium branemark for dental implantology before (left) and after (right) 2 –second electrochemistry treatment.

After acquiring these technologies INFN has proposed the organization of a second level Master on " Surface treatments applied to innovative mechanical technologies for industry", in collaboration with Confindstria Veneto.

The aim is to shape super-experts whom, once learned the most advanced cleaning surface technologies, can simply applied them to the surgical fabrication of prothesis, pivots for dental implantology, titanium cardiac valves, or titanium components for ultra light vehicles, new materials for eye-wear industry, ultra- hard coatings at low friction coefficient for mechanical manufacturing. The master students are trained to use high tech technologies, by learning the surface treatment techniques according to the needs of the National Industry.

Many requests for test executions from Eye-Wear and Gold Industry located in Vicenza district have been hold, although these industries are finding themselves in serious problems because of the Turkish, Indian and Chinese competition

Some feasibility tests were executed and the results are absolutely "brilliant". In figure n° 4 there is a German silver stem before and after the electrolyte treatment.

Fig. 4 - Glasses' stem before and after the electrolyte treatment.

If compared to the actual brushing treatment, the electrolyte treatment offers a higher finishing level, and above all speeds up the cleaning process, since while the brushing action treats

the pieces in a sequential way, the electro-cleaning allows to treat even one thousand pieces simultaneously.

Similarly in the Goldsmith fields, we have performed tests on 18 carat jewels. In fig. 5 is possible to see a rough golden piece before and after our treatment.

Fig. 5 - 18 carat golden chain before and after the electropolishing proposed by LNL.

A very important thing is that the electropolishing treatment proposed by LNL - INFN consists of a bath without cyanide, a substance usually used in the Gold industry. The innovation and simplicity of the treatment we proposed, added to the reduced environmental impact due to the elimination of the Cyanide process, called a big attention from the gold industry of the Vicenza district.

The interested factories, in fact, are joining themselves to organize a transfer of the INFN technologies. For this purpose, we are estimating to propose to INFN the possibility to patent the process.

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