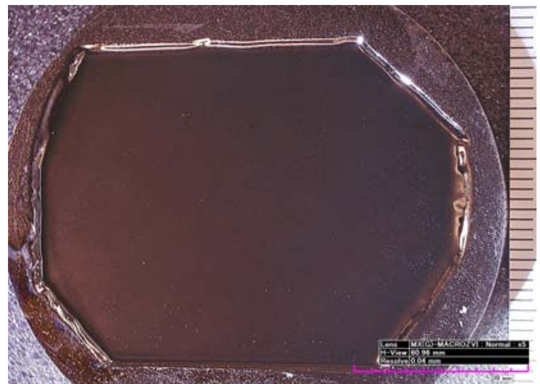
FARADAY TECHNOLOGY®

ElectroPolishing Niobium for Superconducting Radio Frequency Cavities Using the FARADAYIC® Process

Objective:

This project is developing the capability of the patented FARADAYIC® Process for electropolishing strongly passive materials, such as niobium, without the use of toxic, highly aggressive chemicals, such as hydrofluoric acid.

Summary:



Niobium coupon surface polished to an Ra < 50 nm.

Niobium (Nb) is the current material of choice for the fabrication of superconducting radio frequency accelerators due to its excellent superconducting properties. The state-of-the-art polishing technology for Nb uses either chemical polishing or conventional electropolishing; a major disadvantage of both processes is the use of hydrofluoric acid to achieve breakdown of the tenacious passive film on the surface. Faraday is developing an electropolishing process for Nb that utilizes an electrolyte free of hydrofluoric acid, controls surface roughness to a microscale finish, Ra $\leq$ 0.1 µm, leaves the surface free from contamination after polishing, and enables uniform polishing across the entire device. Polishing rates range from 0.8 to 6 µm/min with an Ra as low as 0.05 µm assessed over a 12 mm length. Jefferson Lab assessed the surface finish using AFM giving an Ra of < 1 nm over a 10 x 10 µm area.

HF is also required for polishing medical and dental implants made of Nb alloys. Nb and Nb alloys are hypoallergenic and are commonly alloyed with titanium and zirconium to make implantable metallic biomaterials for medical applications. Other alloys that could benefit from an HF-free electropolishing process include Ti, Ti-Mo, and Ni-Ti (Nitinol).

Background:

The patented FARADAYIC® Process is an electrochemical manufacturing technique that utilizes a controlled electric field to polish a metallic work piece. Since the FARADAYIC® Process is electrically mediated, it does not require aggressive chemicals to facilitate the metal removal as needed in conventional chemical processes (e.g. chemical etching). The material removal rate is determined by the applied electric field, which is user-defined and computer controlled. This provides the means for precise control of the length of the process and the total material removed. Additionally, the use of low viscosity acid (e.g. dilute H_2SO_4) or neutral salt solutions (e.g. sodium chloride and sodium nitrate) as the electrolyte makes the process both worker and environmentally safe.

The FARADAYIC® Process technology illustrated above is protected by a substantial patent portfolio including issued, allowed, and pending patent actions.

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