

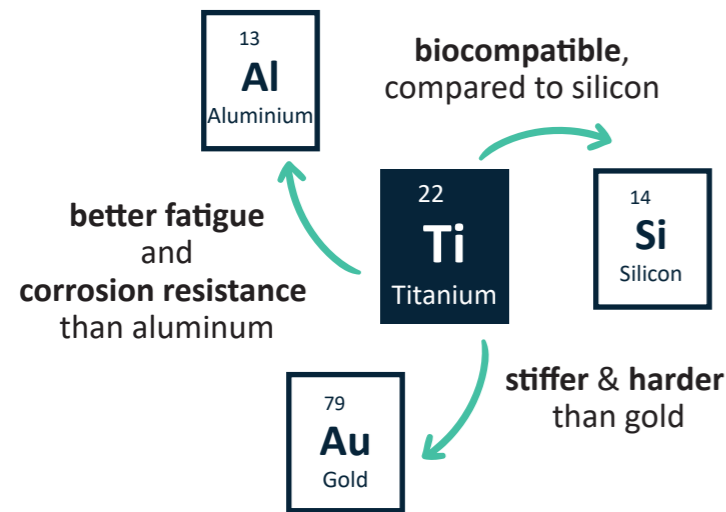
Bulk Titanium Micromachining using Deep Reactive-Ion Etching

Rim Ettouri ^{1,2}, Thomas Tillocher ¹, Philippe Lefaucheur ¹, Bertrand Boutaud ² and Rémi Dussart ¹

¹Groupe de Recherches sur l'Energétique des Milieux Ionisés (GREMI) Université d'Orléans/CNRS 7344, 14 rue d'Issoudun BP6744 – 45067 Orléans Cedex 2, France

²MISTIC SAS, Promenade du Verger – 92130 Issy-les-Moulineaux, France

1 Why Titanium?



2 Applications

The aerospace, chemical and medical sectors rely on titanium's strength-to-weight ratio, biocompatibility and corrosion properties.

"Bio-MEMS"

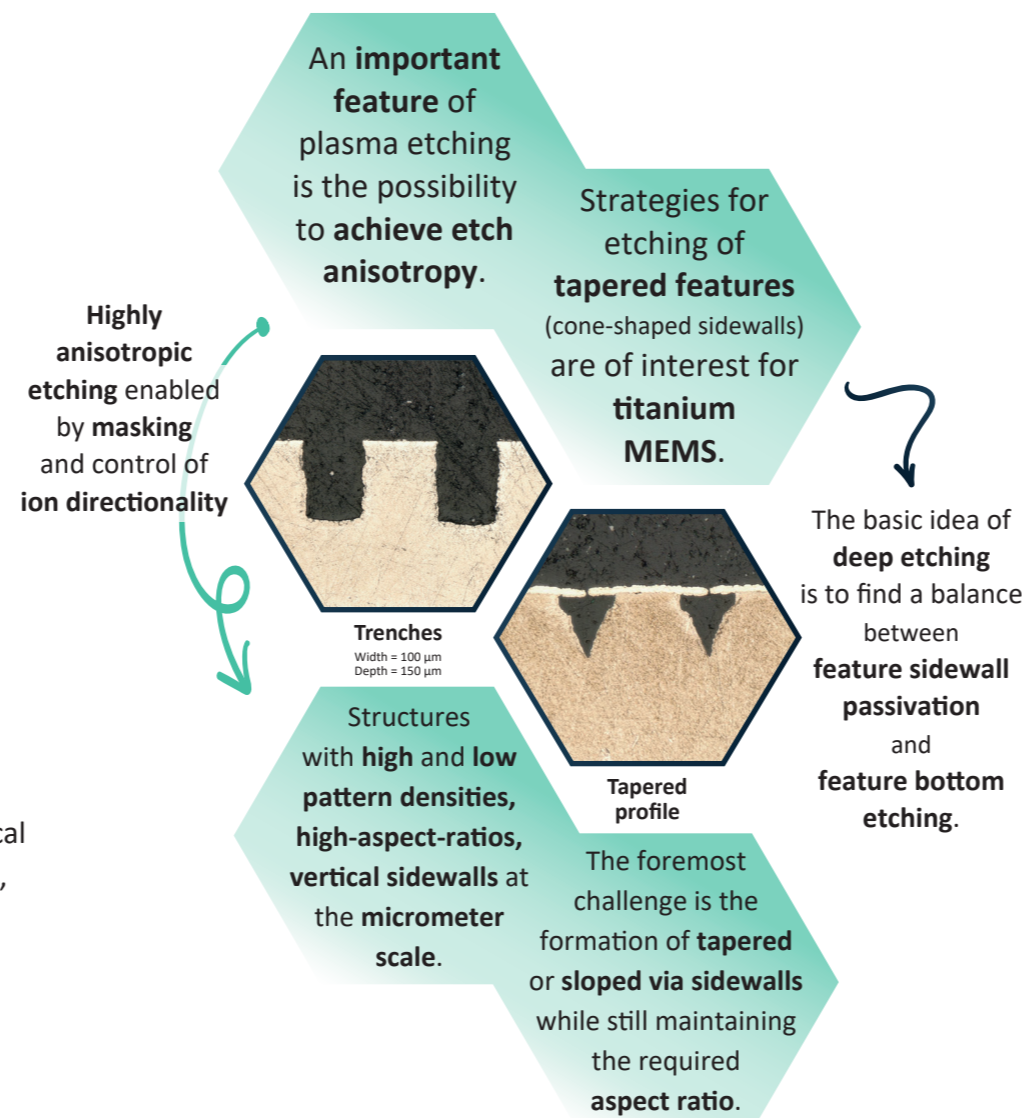
- Functionalizing the titanium-based housing of medical implants:
- Feedthroughs
 - Embedded capacitive filter
 - RF Antenna
 - Electrodes – Sensors

Other non-biomedical fields: watchmaking, aircraft, jewelry, ...

To enable drastic miniaturization, design flexibility, time to market, overall operational gains

3 Titanium deep etching

Reactive-Ion Etching (RIE) combines *chemical etching reactions* with *physical ion bombardment*.



Several processes

- **Mode:** continuous / pulsed (alternating etch and deposition cycles)
- **Chemistry:** fluorine- and chlorine-containing plasmas

Key characteristics of profile

- **Etch rates:** up to 2µm/min
- **Defects:** undercut, bowing, slope (positive, negative, vertical)

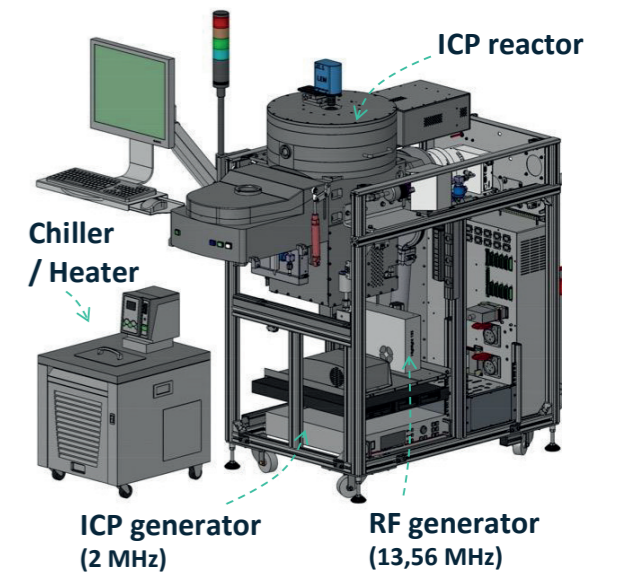
4 Deep etching equipment

CORIAL 210 IL

High density Inductively Coupled Plasma (ICP) etching reactor

Parameters range

- **Pressure:** 5 - 50 mTorr (0,6 - 6 Pa)
- **Bottom-electrode power (RF power):** 0 - 300 W
- **Top-electrode power (ICP power):** 500 - 2000 W
- **Substrate temperature:** 0 - 50°C
- **Gases:** Cl₂, BCl₃, O₂, Ar, N₂, SF₆ and CHF₃



5 Surface & bulk titanium characterization: the effects of various process parameters

- Inductively coupled plasma optical emission spectrometry (ICP-OES) analysis.
- Scanning electron microscopy / energy dispersive X-ray spectrometry (SEM/EDX) qualitative analysis.
- Resolving surface chemical states using x-ray photoelectron spectroscopy (XPS) analysis.
- Surface topography and wetting ability using contact angle.

