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INFORMATION

Innovation in Biomaterials:
Titanium Foams for Tissue Attachment

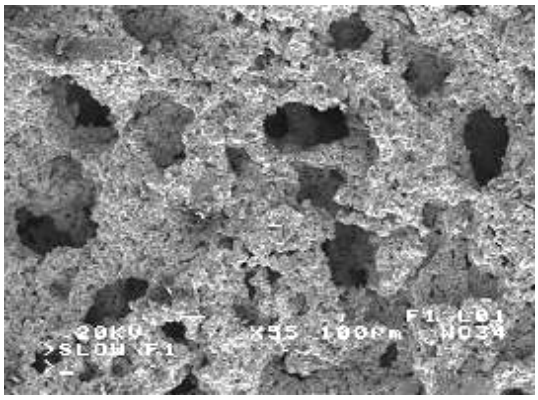
NRC's Industrial Materials Institute (IMI) has recently developed a new manufacturing process to produce metallic foams. The unique open-cell structure of NRC-IMI's metallic foams makes them attractive for the fabrication of biomedical implants. These foams are characterized by structures and properties matching those of bones.

A New Biomimetic Material

NRC-IMI's metallic foams feature:

- High porosity (70%-85%)
- Permeability (i.e. pore size between 50-400 µm)
- Structures and properties similar to those of bones

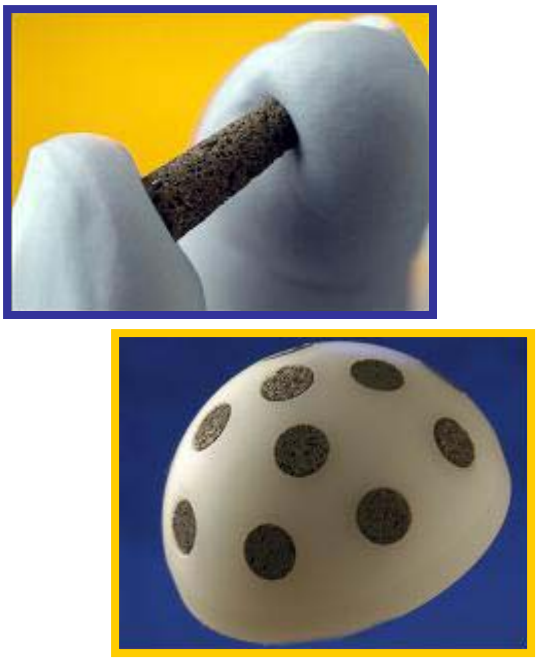
Their unique structure, corrosion resistance, biocompatibility and mechanical properties make these materials attractive for tissue attachment. The targeted applications are porous implants and attachments systems for orthopaedic and dental applications.



SEM micrograph of an NRC-IMI's titanium foam

Fabrication Process

NRC-IMI's proprietary process, combining powder metallurgy and polymer foam technologies, allows the production of materials having different structures and properties. It can be used to produce components into different forms, such as fully porous bodies or coatings on solid structures.



Prototypes of porous Ti attachment systems for dental implant (coating) and acetabular cup (inserts)

Our researchers are currently working on optimizing the process, as well as on the evaluation of the effect of different materials and manufacturing conditions on the foam's microstructure and properties.

Material Properties and Characteristics

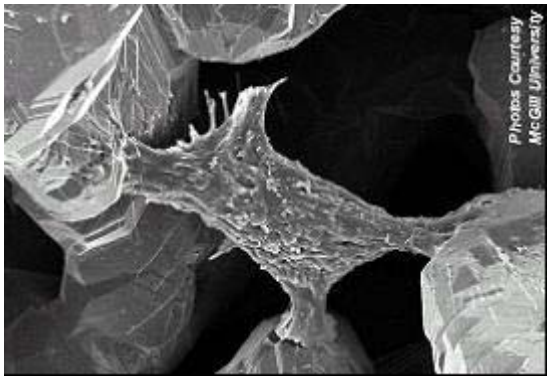
The mechanical properties of the Ti foams are remarkably close to those of bones (*see Table 1)*, as opposed to solid Ti currently used in orthopaedic and dental applications. Matching the properties of the implants with those of the bones is crucial to avoid stress shielding that may cause implant loosening.

Table 1: Comparative compressive mechanical properties

Materials	E (GPa)	$\sigma_{y,c}$ (MPa)	$\varepsilon_{y,c}$ (%)
Ti foams	0.6 – 2.2	10-50	2-5
Solid Ti	110	175	-
Trabecular bones	0.4 - 2	5-15	2-5

Evaluation of the corrosion current densities and the penetration rates confirmed the excellent corrosion resistance of the foams in a simulated body fluid (SBF). In fact, corrosion potentials of these Ti foams are superior to those of solid Ti in a SBF solution at 37°C. The presence of a thin oxide layer on the surface of pores, formed during the fabrication process, is responsible for this passive behavior of the materials.

Preliminary *in vitro* biocompatibility assays showed no differences in cell concentration between mouse monocyte-macrophages in contact with foams over 24h and controls. In addition, SEM analysis demonstrated the cell attachment to the Ti foam surface indicating that the material is not hostile to cell growth.



SEM micrograph of mouse monocyte-macrophages cultured at 37°C, 100% humidity, 5% CO_2 in RPMI medium (5%SFB, 1% streptomycin-penicillin)

IMI Team

Drawing on its experience in advanced materials design, modelisation and diagnostics, IMI has carried out many projects that have led to significant breakthroughs for the industry. The IMI team is now ready to adapt its new metal foam technology to the needs of the biomedical industry.

NRC-IMI's facilities in Boucherville including the new prototyping and incubation facilities

Business Opportunities

Opportunities are now available for companies and research centers interested in the development and use of tissue attachment systems. Through R&D projects and pre-competitive research, IMI works with companies and helps them in a progressive technology transfer process. The collaborations available are tailored to the operational conditions. To find out more about these opportunities, please contact:

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