Metallurgical and Materials Engineering of COPPE/UFRJ: from 1967 to Biomaterials

Gloria de Almeida Soares

‘Mecânica, Materiais Avançados e Nanotecnologia’
Metallurgical and Materials Department

Academic Staff: 31
Technical & Administration Staff: 27

- Teaching (undergraduate and graduate levels)
- M.Sc. and Ph.D. Projects
- Cooperative Research and Exchange
- Technological Projects, Evaluations and Consulting Services


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Research Facilities ≈ 2,500 m²
**ACADEMIC RESULTS**

**Undergraduate:** more than 600 (Metal. & Materials)

**Graduates degrees more than 600 (up to dec. 2003)**

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>M.Sc.</th>
<th>Ph.D.</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1967-1997</td>
<td>363</td>
<td>52</td>
<td>415</td>
</tr>
<tr>
<td>1998-2000</td>
<td>79</td>
<td>30</td>
<td>109</td>
</tr>
<tr>
<td>2001-2003</td>
<td>73</td>
<td>40</td>
<td>113</td>
</tr>
<tr>
<td>TOTAL</td>
<td>515</td>
<td>122</td>
<td>637</td>
</tr>
</tbody>
</table>

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Research Groups:

- Mineral Processing and Extractive metallurgy
- Thermomechanical processing and microstructural eng.
- Physical metallurgy and mechanical properties
  - Welding and non-destructive testing
  - Corrosion
  - Surfaces and thin films
  - Advanced ceramics
  - Biomaterials

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BIOMATERIALS:

Start: 1995

Academic results: 24 M.Sc and 6 D.Sc.

Research Themes:


• Materials for implants: surface treatments on titanium and titanium alloys. Bioactive coatings.

• Correlation between properties and microstructure on dental ceramics.

• Corrosion of metallic alloys.

• Polymer and Composites for Restorative Function.

• Failure analysis on dental restoration

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Materials for bone-substitution: Calcium Phosphate (CaP) Materials

- characterization of commercial CaP granules
- multiphase, micro or macroporous granules or tablets
- hydroxyapatite-collagen composites
- Zn-containing hydroxyapatite

- Bone graft
- Scaffold for cell therapy
- Carriers for drug delivery
1. Commercial granules

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Conz, M.B., 2003
2. CaP porous tablets

[Bar chart showing pore distribution (%)]

- 20 wt.% naphthalene
- 40 wt.% naphthalene

[Graph showing range of pore size (µm)]

- SEM image

Oliveira, J.F., 2003
3. HA-collagen composites

$L_{002} = 17 \text{ nm}$

$L_{300} = 7 \text{ nm}$
4. Zn-apatites calcinated at 1150°C

5%Zn - calc

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Costa, A.M., 2004
5. Cell culture on HA/α-TCP tablets

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>COMPOSITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>$CD_b$</td>
<td>59.8 HA - 40.2 α-TCP</td>
</tr>
<tr>
<td>$E_b$</td>
<td>95.4 HA - 4.6 α-TCP</td>
</tr>
</tbody>
</table>

![Cell culture on HA/α-TCP tablets](image)

![Graph showing cellular density over time](image)
BONE FORMATION
Depends on:

- Surface Energy
- Topography
- Surface Composition

Materials for implants:
Titanium and Ti-alloys

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Jones, J., 2001
1. Surface Treatment on cp Titanium

![Graph showing calcium content into SBF (mg/L) vs soaking time (days).](image1)

- Ti-control
- Ti-etched
- Ti-etched + oxide 1
- Ti-etched + oxide 2

![Scanning electron microscopy images.](image2)

- a: Ti-acid + oxide 1
- b: Ti-acid + oxide 2
- c: Ti-etched + oxide 1
- d: Ti-etched + oxide 2

![Binding energy (eV) vs intensity graph.](image3)

- Ti
- Ti-acid
- Ti-acid + oxide 1
- Ti-acid + oxide 2

Vanzillotta, P.S., 2003
2. Anodic oxidation with $\text{H}_3\text{PO}_4$
3. Ti Implants coated with HA by Electrophoresis

Costa, C.A., 2002
The future for biomaterials lies not in individual product areas, but in creating a marriage between materials science and biotechnology.

http://www.ecf.utoronto.ca/~bonehead/

Thank you!