FACULDADE DE CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE NOVA DE LISBOA

CENIMAT | i3N

SEMINÁRIO

Data: 26 de Setembro de 2014
Hora: 14h30
Local: Anfiteatro Leopoldo Guimarães

"Nanostructured Ni-Ti alloy with shape memory effect for medical application"

By Ph.D. student Pavel Mazaev

Kotel'nikov Institute of Radio-Engineering and Electronics of RAS (Russia)

Abstract: Nowadays materials used for the manufacture of implants are not compatible with living tissue and rejected by the body, requiring replacement of the implant. Nanostructured Ni-Ti alloy, due to its biocompatibility with living tissue and mechanical compatibility with bone tissue, is the most promising material for the manufacture of implants, in particular, dental [1-3].

$Ni_{49,8}Ti_{50,2}$ alloy with shape memory effect was chosen for study. The samples represent different thermomechanical treatments such as equal channel angular pressing (ECAP), standard technology for bulk materials and forging technology. ECAP method is suitable to make nanostructures, but the distribution of the grain size appears to be nonuniform through samples' section and an amorphous structure is obtained, which leads to a process of softening of the material. In the case of the standard methods semi-products average grain size is equal to 0.5 µm, but, due to the dislocation structure, functional properties of these samples as high as the properties of samples after ECAP are obtained. After the process of forging, structure with an average thickness of 100 nm plates and high density of dislocations were formed.

By using three-point bending method, the primary hysteresis curves of the phase transformation under variable loads are obtained. These curves contain information about characteristics of the phase transformation and functional properties. The functional inflexibility and energy capacity are proposed as new general characteristics of the material.

Using energy capacity and functional inflexibility, it became possible to defy the material that demonstrates the highest functional characteristics. As the studied alloy has a medical application, the most preferred material for the implant is the sample after ECAP, possessing high recoverable strain (about 6-7 %) while reversible stress is about 1200 MPa. But ECAP is proposed to be not very effective method of nanostructurization because of noncontrollable process of recrystallization during the processing and large size of blank. In other case, the best functional properties has been obtained for the sample after the forging process, due to its high general characteristics such as energy capacity and functional inflexibility.

References

1. V. Brailovski, S. Prokoshkin, P. Terriault, F. Trochu, Shape Memory Alloys: Fundamentals Modeling and Applications, ETS Publ, Montreal, Canada, 2003, 851;
2. Gunter V. with co-author Titanium nickelide. Medical Supplies of the new generation. Tomsk, Moscow-MIC, 2006, 296;
3. Gizatullin R. Treatment of chronic destructive forms of periodontitis, a combination of porous TiNi with osteoplastic drug "CollapAn-gel". The collection "Biocompatible shape memory materials and new technologies in dentistry", 2006.