Synthesis and nanomechanical characterization of hybrid Ti/PMMA materials for medical devices

M. Reggente[1,2], M. Natali[2], D. Passeri[2], G. Pourroy[1], P. Masson[1]
H. Palkowski[3], M. Rossi[2,4], A. Carradò[1]

[1]*Institut de Physique et Chimie des Matériaux de Strasbourg, UMR 7504 CNRS - Université de Strasbourg, France*
[2]*Department of Basic and Applied Sciences for Engineering, Sapienza University of Rome, Rome, Italy*
[3]*Institute of Metallurgy, Clausthal University of Technology, Clausthal-Zellerfeld, Germany*
[4]*Research Center for Nanotechnology applied to Engineering of Sapienza University of Rome (CNIS), Rome, Italy*

**melania.reggente@uniroma1.it*

This research activity concerns the fabrication of innovative biocompatible hybrid interfaces made of a titanium (Ti) surface and a poly(methyl methacrylate) (PMMA) film. Indeed, these kinds of systems, which combine titanium with acrylic polymers, are of particular interest for the fabrication of many medical implants [1,2]. Currently, in these devices, polymers are generally not linked to the metallic surfaces by strong bonds and the weak adhesion between the two components may provoke delamination phenomena and/or mechanical failures resulting in a short-term stability [3,4].
Our aim is the development of a new strategy to establish chemical covalent bonds between Ti surfaces and PMMA films, improving their adhesion, in order to prevent delamination phenomena and design biocompatible layered structure (Ti/PMMA). First of all, the Ti surfaces were physically and chemically activated in order to remove the native oxide layer which passives the surface. Then, the organic polymerization initiator molecules were grafted through covalent bonds on the activated Ti surfaces. Finally, the polymer chains were grown starting from the previously anchored initiator molecules using a Control Radical Polymerization (CRP) of the methyl methacrylate monomer. In order to evaluate the mechanical stability of this new layered structure, we investigated the mechanical properties of the synthetized PMMA films through different Atomic Force Microscopy (AFM) based techniques [5]. In particular, quasi-static AFM-based indentation, Contact Resonance AFM (CR-AFM), Torsional Harmonics AFM (TH-AFM), and peak force quantitative nanomechanical mapping (PF-QNM) have been synergistically employed to characterize the elastic (i.e., Young's modulus and indentation modulus) and viscoelastic (i.e., storage and loss moduli and loss tangent, tanθ) properties of the samples. The results are compared and discussed.

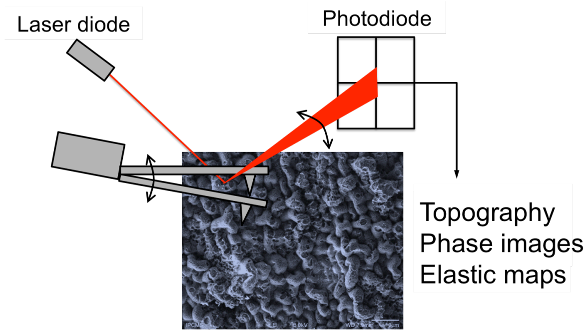

Figura 1 Schematic representation of the working principle of AFM on a PMMA film (SEM micrograph)

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