Biomolecules thin films prepared by Pulsed Laser Deposition

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Thin films of biological molecules such as amino-acids or proteins are of increasing interest for applications for bio-sensors or biocompatible coatings and their development needs diversification in the methods used to elaborate and structure them. Such films are generally prepared as monomolecular layer from solutions (Langmuir-Blodgett) or by chemical grafting of portion of biopolymer chains on surface. In order to investigate alternative methods, we study the ability of pulsed laser deposition to provide thin films, for which the molecular structure is preserved and which have, in addition, optical waveguiding properties, which may lead to interesting applications for sensors.

Three kinds of molecules have been studied to evaluate this capacity: amino-acids (phenylalanine, tyrosine…), calix-[n]-arene, which are macrocyclic molecules exhibiting specific complexation properties for amino-acids or proteins and a protein, the bovine serum albumin (BSA).

The thin films were deposited on silica substrates, using ablation of pressed powder targets by a KrF excimer laser at room temperature and low pressure (about 10^{-5} mbar). Films with thickness of about 500nm to several µm could be obtained. The conservation of the chemical structure of the molecules was verified by IR spectroscopy and could be obtained for laser fluences of some hundreds mJ/cm^2. The surface roughness and morphology were examined by AFM. The films of the three kinds of molecules are optical waveguides and their thickness and refractive index were measured by m-line spectroscopy.

Films of phenylalanine have low roughness and high refractive index. They have the orthorhombic structure of the crystalline phenylalanine powder but the arrangement of the molecules, revealed by the hydrogen bonding, is slightly modified.
Films of ^{t}Bu-calix-[4]-arene are characterised by refractive index clearly higher than those of films obtained by thermal evaporation or from solutions, low surface roughness and specific cristallisation properties after annealing.

Waveguiding thin films of the globular protein BSA could be obtained without degradation of the molecular structure. Observation by AFM of the film surface shows the presence of particles of about 100 nm diameter, a morphology different from that of films cast from solution. These films are characterised by a very low roughness (rms=1.3nm).