

Structural coatings, Surfaces studies and ionic implantation

The properties of the surface of different substrates are modified by means of two techniques: the first one is ion implantation with energies ranging between 100 to 400 keV and the second one is coating of a surface with a hard amorphous carbon film or a related material. The aim of the ion implantation techniques is to modify the properties or the structure of the surface of different materials. The purpose of the second one is to grow hard films using different ion beams, to protect the surface from the wear caused by abrasion or chemical attack. The principal protective coatings so far produced and studied are: hard amorphous carbon films (a:C) of about 1 mm thickness, N containing a:C films and amorphous carbon rich SiC films. It is particularly relevant to determine which composition and microscopic structure give the compound greater thermal stability, hardness and /or wear resistance.

The physical properties of these films and of the modified substrate are evaluated by various methods: Raman spectroscopy to study the amorphous character of the films, XPS and EELS for structural and compositional studies, heavy ion beam techniques (HIRBS and ERDA) to determine the concentration of different elements in the film and on the treated surface and positron annihilations spectroscopy (PAS) to estimate the size of clusters forming the amorphous matrix. Tribological properties are studied measuring indentation hardness, elastic modulus, wear resistance and scratch damage.

In the last years, a wide range of new carbon structures (from polymeric to a-C) has been prepared from fullerene C_{60} under high pressures and temperatures. It has been demonstrated that high-pressure-induced polymerization or amorphization of solid C_{60} gives as a result superhard carbon structures with very interesting electrical behaviors. In our laboratory, the high pressure and high temperature are replaced by a dynamic process of deposition of fullerenes with different energies, inducing bonds between carbon atoms of neighboring C_{60} molecules, forming carbon films with different short range organization depending on the ion beam energy.

Hydrogen-free carbon films have been produced accelerating C_{60} ions on silicon substrates. C_{60}^+ ions were obtained from fullerene powder at high temperature using a filament-discharge ion source. C_{60} ions have been accelerated to different energies (from 100 to 2000 eV) on the substrates.

The obtained films have been characterized by EELS, Raman spectroscopy, PAS, XPS, electrical resistivity and indentation hardness measurements.

During the last years, several developments have been performed using a heavy ion beam in the analysis of material (ERDA and HIRBS techniques), in particular, in the determination of the concentration profile of elements in the zone near of the surface of the material (around one micron).

At present our main objective is to reduce the difficulties connected with the ERDA technique, for example the gas handling system of our detector, the data analysis and the complicated experimental setup in general. To fulfill this we planned different tasks such as: improving the gaseous detector, developing a new data acquisition systems based on a standard personal computer (PC) and using a particular software for data analysis, and finally the installing a dedicated scattering chamber. In summary, the principal purpose is to develop a reliable experimental setup, which could be used by different groups without major difficulties to get high quality analytical results as fast as possible.