C_{60}/SI AND C_{60}/SiO_2 COMPOSITE THIN FILMS: A PHOTOELECTRON SPECTROSCOPY STUDY OF THEIR MATRIX-DEPENDENT THERMAL STABILITY

Teresa de los Arcos[*], *Peter Oelhafen*[*], *Concepción Domingo*[♣]
[*]*Department of Physics, University of Basel, Klingelbergstr 82, CH-4056 Basel Switzerland,*
[♣]*Instituto de Estructura de la Materia, CSIC, c/Serrano 123, 28006 Madrid, Spain*
t.arcos@unibas.ch

Cluster-based materials are highly versatile systems with a wide range of applications in nanotechnology.

In the case of fullerene-composite films, most studies to date concentrate on the fundamental aspects of the composite film growth, the electronic properties of the interface between cluster and fullerene, and the electronic properties. However, there are relatively few studies where the incorporation of fullerenes in a semi-conducting matrix has been attempted, and to the extent of our knowledge nothing has been done on dielectric matrixes.

In this work we present measurements done in a co-deposition experiment of fullerenes and Si or SiO_2 matrix. In-situ analysis of the deposited films was done with photoelectron spectroscopy in the X-ray range (XPS) and UV-range (UPS). This has allowed us to follow the compositional changes and the modifications in the electronic structure of the valence band with increasing temperature. The films where further analyzed ex-situ by micro-Raman spectroscopy.

We have investigated the stability of the films, and the tendency of the fullerenes to form chemical binding with the surrounding matrix, as function of temperature. The deposition method is a combination of evaporation technique (for the fullerenes) and non-reactive sputtering (for the Si or SiO_2 matrix). We have observed marked differences in temperature-dependent stability of the films as a function of the surrounding matrix.

When C_{60} is co-deposited with pure Si, there is a small fraction of C which binds to the Si, forming carbide, even at room temperature. Progressive annealing of the film results in massive formation of more SiC for temperatures above 700°C, which consumes all the available Si.

By contrast, co-deposition of C_{60} with SiO_2 (by sputtering of a quartz target) results in a very stable film. Similar to the previous case, there is a small fraction of the original C_{60} that has been oxidized already during the deposition at room temperature. However, unlike the Si case, the SiO_2 matrix provides a great thermal stability to the fullerenes, which do not undergo any chemical transformation, (neither carbidization nor oxidation) during annealing up to temperatures close to the decomposition temperature of the C_{60}.