ABSTRACT

The investigation of nanomechanical properties is crucial for advancing in many technologies and applications, since several materials are implemented in a micro- to nanoscale. The flexible organic electronics technology makes use of materials such as polymers, which have special properties (for example advanced mechanical properties)
in conjunction with the low cost, availability and easy production.
The main goal of this project is to present and compare some of the most popular methods of experiment analysis, performed by Nanoidentation, for the determination of
the materials mechanical properties. Additionally, the effect of radius of curvature of the indenter and the use of different loading rate to the calculation of the mechanical properties is being studied.
More specifically, **the first chapter** includes a brief description of polymers with their corresponding categories depending on their morphology and their physical and mechanical behavior. Following, the factors affecting the mechanical properties are mentioned (temperature, structure, time load or creep), and some of the most basic mechanical properties. Some of the most important analysis techniques, based on rheology principles are described. These techniques include the *Maxwell* and *Kelvin-Voigt* model, the generalized model of *Kelvin*, and finally the *Oyen-Cook* model.
In the **second chapter** there is a description of the Nanoidentation method (quasistatic and dynamic) and a brief reference to the different kinds of indenters that are being used (conical and spherical) and a comparison between them. Next, the characteristic depths of the load - displacement curves are described for the cases of two indenters, so that the reader can gain an overview of the transition from elastic deformation to rubber-plastic and then to plastic deformation. Finally, some detailed analysis techniques follow for the calculation of modulus E and hardness H, which include the Oliver-Pharr method and the Oyen-Cook model.
The **third chapter** describes briefly the experimental system (Nanoindenter) and the experimental conditions. The study of mechanical properties with the two loading protocols CLR and CSM, is also described. The chapter concludes with comparisons between the two loading techniques and the analysis techniques of mechanical properties E and H.
The **forth chapter** refers to the analysis of the experimental data provided with the use of spherical indenter. The division of the displacement regime into different zones (elastic, elastic-plastic and fully plastic) is particularly emphasized due to its importance on the correct assessment of experimental data. The value of the indenter radius of curvature is being confirmed, and an extensive comparison and analysis follows among the data obtained with sharp and spherical indenter (for the PC).
The **fifth chapter** is dealing with the study of the influence of the loading technique and the radius of curvature of the tip to the creep behaviour. It also includes a comparison among the various techniques for the study of creep and their use in assessing the measure of flexibility.
Annex A includes tables with coefficient values obtained from the fitting procedure and are directly related to the use of MATLAB.
Finally, in Annex B there is a table including a summary of the most important models in bibliography, for the study of the thin films / substrates mechanical properties, by chronological order.