Nanoindentation of conducting polymer films deposited onto silicon surfaces by electropolymerization

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Abstract

Organic-inorganic hybrid heterojunction cells are a novel class of photovoltaic devices which are under considerable research efforts. The fundamental idea is to combine the advantages of the organic materials (e.g. their low processing cost) with that of the inorganic semiconductors (e.g. the high reliability of their electrical properties). Promising results have been identified in literature, however there are several issues that should be tackled. One of the most important is the inherent incompatibility of the interphases, which should be adapted for adhesion and (depending on the functionality of the layer) charge transport or separation. Electropolymerization seems an effective approach as polymer formed near the surface is grafted onto the surface of the electrode. However, in the case of silicon this is not an easy task, due to its band structure and low surface adhesion. To circumvent this, an interesting approximation is to modify the silicon surface with a covalently bonded interphase which is in turn able to bind the respective polymer layer during the electropolymerization process. The interphase between silicon and the electrochemically grafted polymer can be also evaluated using nanoindentation: the better the interfacial adhesion, the higher the nanomechanical properties of the films will be.

The aim of this work was to produce conducting polymer films grafted onto silicon surfaces by electropolymerization and to study their nanomechanical properties through nanoindentation. Hydrogen terminated crystalline silicon wafers were used to form conducting polymers and copolymers by electropolymerizing different monomers. The effect of prior electrochemical Grignard treatment on the deposition of the films will be presented. The morphology of the deposited films will be visualized by scanning electron microscopy and their structure by means of Raman spectroscopy. The nanoindentation of the films will provide further insight on the adhesion of conducting polymer films formed onto the surface of silicon.