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AFM and FTIR characterization of microcrystalline Si obtained from isothermal annealing of Al/a-Si:H

M. Rojas-López[1], **A. Orduña-Díaz**[1], **R. Delgado-Macuil**[1], **J. Olvera-Hernández**[*, 2], **H. Navarro-Contreras**[3], **M. A. Vidal**[3], **N. Saucedo**[3], and **V. H. Mendez-García**[3]

[1] Centro de Investigación en Biotecnología Aplicada (CIBA), IPN, Tlaxcala, Tlax. 72197, México
[2] Centro de Investigación en Dispositivos Semiconductores (CIDS), BUAP, Puebla, Pue. 72570, México
[3] Instituto de Investigación en Comunicación Óptica (IICO), UASLP, San Luis Potosí, S.L.P. 78100, México

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Atomic force microscopy and Fourier transform infrared spectroscopy were used to investigate the morphology of the microcrystalline surface, and also the amorphous-crystalline structural transformation of a-Si:H films, isothermally annealed during several hours. Crystallization process was strongly influenced by the deposition of an Al layer on the surface of a-Si:H samples. Representative AFM images show the presence of grains, which increase in diameter with the annealing time. Relative crystallized fraction as a function of the annealing time can be described adequately by using the Avrami equation. The kinetic of this crystallization process suggest a two-dimensional growth of the Si nuclei. Fourier transform infrared measurements show the presence of an intense band near 512 cm^{-1} associated to Si–Si bonding. We observed the relative diminishing of the intensity of the Si–H wagging mode at 694 cm^{-1} with annealing time, suggesting effusion of hydrogen to the surface of microcrystalline films.

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1 Introduction

Hydrogenated microcrystalline silicon (μc-Si:H) has a recognized technological importance because of their important device applications such as a window layer as well as top contact layer in hydrogenated amorphous silicon (a-Si:H) based solar cells. In particular, doped μc-Si:H films as p or n layers [1] have received considerable attention due to their high conductivity and low activation energy of conductivity. Heavily phosphorous-doped μc-Si:H films are being widely used as an ohmic contact layer in thin film transistors (TFTs) [2]. Plasma enhanced chemical vapor deposition (PECVD) method is one of the most popular techniques to prepare μc-Si:H films. However μc-Si:H also can be obtained trough the metal induced crystallization (MIC) effect [3]. It is well known that the deposition of a metal onto the a-Si:H film and its subsequent annealing induces microcrystallization [4]. In this process, it has been observed the formation of c-Si grains with considerable grain growth when noble metals showed up [5]. In these grains of micrometric length, the internal structure change from the amorphous to the microcrystalline phase turning out an a-μc phase transition metal-induced. This a-μc phase transition has been investigated by some researchers using metals such as Au [4], Cr [6] and Ni [7], and Al [3] to decrease the crystallization temperature of a-Si:H at a lower temperature as compared to its normal crystallization temperature of pure Si of about 600 °C [8]. The study of such crystallization process, on this kind of

[*] Corresponding author: e-mail: jolvera@siu.buap.mx, Phone: +52 222 2295500 Ext. 7877, Fax: +52 222 2330284

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