physica status solidi a

phys. stat. sol. (a) **204**, No. 4, 1014–1017 (2007) / **DOI** 10.1002/pssa.200674146

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

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Received 13 May 2006, revised 17 July 2006, accepted 20 February 2007
Published online 30 March 2007

PACS 61.30.Dq, 61.72.Cc, 63.50.+x, 68.37.Ps, 78.30.Am, 81.40.Ef

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.

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

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