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Morphological transformation and kinetic analysis in the aluminum-mediated a-Si:H crystallization

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Abstract

We analyzed the amorphous–crystalline morphological transformation of a-Si:H films caused by applying an annealing treatment to the Al/a-Si:H system at low temperature (250 °C) during several hours. Optical micrographs show the growth of Si nuclei formed on the amorphous matrix and also a t^2 dependence of the average area of these crystalline grains, which suggest a bidimensional growth. Also was investigated the growth kinetics in the μc-Si:H films considering the annealing time dependence of the crystalline fraction. The application of the Avrami equation showed a good description of the experimental results during this morphological and structural transformation. The low growth velocity measured $V_g = 7.2 \times 10^{-3}$ μm/min is a direct consequence of the low annealing temperature applied (250 °C), which reduces the silicon diffusion across the interface Al/a-Si:H. Infrared reflectance measurements show a relative diminishing of the intensity for Si–H wagging mode with annealing time, suggesting effusion of hydrogen to the surface of the μc-Si:H films.

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1. Introduction

The development of suitable preparation techniques for large-grained microcrystalline silicon (μc-Si:H) films on low-temperature substrates is an important challenge for the photovoltaic research in the next years. This material 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, have received considerable attention because of 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) [1]. Plasma enhanced chemical vapor deposition (PECVD) method is one of the most popular technique utilized to prepare μc-Si:H films [2]. However, μc-Si:H also can be obtained through the metal induced crystallization (MIC) effect [3]. It is well known that metal deposition onto the a-Si:H film and its subsequent annealing, induces microcrystallization [4]. In this process also has been observed the formation of c-Si grains with considerable grain growth when noble metals are present [5]. In these grains of micrometric length, the internal structure change from the amorphous to the microcrystalline phase resulting in an a–μc phase transition metal-induced. This a–μc phase transition, has been

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