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Abstract

Silicon nanocrystals (nc-Si) or nanoparticles (np-Si) embedded in a dielectric matrix have been studied extensively for potential application in Si-based optoelectronic devices or photovoltaics. Typically, nc-Si embedded in a SiNx matrix are conventionally fabricated by plasma-enhanced chemical vapor deposition, followed by high-temperature annealing at 1000 °C or more. In this work, we used magnetron sputtering to deposit silicon-rich-nitride (SRN) films on anodic aluminum oxide (AAO) substrates to achieve the formation of nc-Si embedded into the SiN_x matrix after low-temperature annealing. Commercial AAO templates, with mean pore diameters of 100 nm and 200 nm, were used for SRN deposition and annealing at the relatively low temperature of 700 °C. The morphology, crystallization, bonding and photoluminescence (PL) behavior of the annealed SRN thin films on the AAO substrate were examined by GIXRD, HRSEM, and Raman, Fourier transform infrared and PL spectroscopy. Due to the spatially confined synthesis of the AAO templates, red-shifting of the PL peak was observed in the annealed SRN on the 200 nm AAO template, compared to that on the 100 nm one. The effects of pore diameter and their boundaries on the evolution of microstructure and PL behavior of the SRN on AAO template was investigated in detail.

Keywords: Silicon-rich-nitride; Magnetron sputtering; Photoluminescence; Microstructure; anodic aluminum oxide

1. Introduction