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Solid-phase crystallization of amorphous hydrogenated silicon suboxide thin films deposited by gas-jet electron beam plasma CVD method.

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In recent years, silicon nanocrystals embedded in amorphous silicon suboxide matrix have attracted more and more attention and considered as a promising material for potential applications in the fields of optoelectronics, photovoltaics, and single electron devices. Silicon quantum dots exhibit strong quantum confinement and therefore their optical and electrical properties can be tuned by controlling their size, density, crystalline structure and surrounding matrix. In this work, solid phase crystallization of amorphous silicon suboxide (a-SiOx:H) thin films deposited by gas-jet electron beam plasma chemical vapor deposition method and annealed in vacuum has been investigated. The experiments were carried out in a vacuum chamber at a pressure of 22 Pa. The total gas flow rate was determined by the Ar at a flow rate of 370 sccm and SiH4 at a rate of 5÷50 sccm. Oxygen was supplied into the vacuum chamber at a flow rate of 6 sccm throughout the experiment. The processing gas was activated by an electron beam with an energy of 1600 eV and a current of 60 mA. The substrate temperature was 260°C. The substrates were c-Si wafers. Next the thin films underwent the annealing process in a vacuum. Raman analysis shows that the Si-Si bonds have an amorphous structure in the as-deposited films. FTIR measurement showed an increase of the hydrogen concentration from 8 to 12% with increasing monosilane flow rate. Simultaneously oxygen concentration remained practically unchanged and amounted to about 10%. Annealing the films in a vacuum chamber led to the formation of silicon nanocrystals embedded in amorphous silicon suboxide matrix. The crystallite size of 3-7 nm was determined by XRD and Raman scattering. Thus, the crystalline volume fraction increased from 40% to 60% with increasing monosilane flow rate.

Keywords
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