Si-rich oxide films prepared by ion-beam-assisted sputtering

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Silicon-rich oxide (SRO) films have attracted attention recently for photovoltaic application. This study exploited the material and optical properties of SRO films that were prepared by ion-beam-assisted sputtering (IBAS). The $\text{Si}^{0+}/\text{Si}^{4+}$ ratio of SRO films was increased when the anode voltage increased from 0 to 40 V. Contrarily, the $\text{Si}^{0+}/\text{Si}^{4+}$ ratio was decreased for the sputtered samples. The X-ray diffraction peaks of Si(111) was slightly shifted when the anode voltage increased, indicating that the stress status was changed. The size and density of the silicon nanocrystals prepared by different methods were calculated and were correlated with the ion energies by transmission electron microscopic images. The room-temperature photoluminescence was employed to investigate the band gap and quantum confinement effect of Si nanocrystals. The mechanism of IBAS process was investigated in detail, suggesting that the ions changed the bonding behaviors of SRO films and lowered the barrier to form the Si NCs, reducing the required process temperature.