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Silicon cluster volume fraction of silicon thin films prepared by multi-hollow plasma discharge CVD

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During silicon thin film deposition by PECVD, silcion clusters generated in silane discharges can be incorporated into films and such incorporation may change considerably their electronic and optical properties depending on the size, structure, and volume fraction of nanoparticles incorporated into films. In this study we report new method for measuring cluster volume fraction (V_f) in silicon films. It is achieved by comparing deposition rates of the films with and without clusters by using quartz crystal microbalances (QCM's) together with a cluster-eliminating filter [1].

To measure the volume fraction of clusters incorporated in silicon thin film, we prepared three quartz sensors under the powered electrode of multi-hollow plasma discharge CVD [2]. By detecting the variation of frequency from the quartz sensor we obtained the information on deposition rate. One quartz sensor was used for measuring the amount of deposition radicals with silicon clusters, and the other sensor was applied for measuring amounts of only deposition radicals which can be obtained by setting the cluster eliminating filter above the quartz sensor. The third sensor was used as a reference sensor because the detected frequency from quartz crystal is affected by the temperature and pressure around the quartz sensor.

Figure 1(c) shows substrate temperature dependende of Si cluster fraction (V_f) of deposited film which is deduced from depostition rate (DR) with and without cluster eliminating filter as shown in Fig. 1 (a). Fig. 1(b) shows intensity of Si*, SiH* intensity measured opical emission spectroscopy during QCM experiments. The volume fraction decreases considerably with increasing the substrate temperature. These results give us useful information on amount of Si clusters incorporated into films when we deposit films [3].

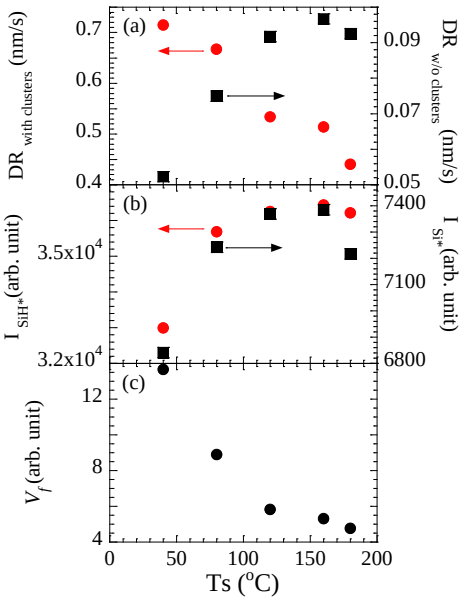

Figure 1 Substrate temperature dependence of amounts of silicon clusters incorporated into deposited film

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