KrF Excimer Laser 248 nm Treatment of Silicon Thin Films: Investigation of Microstructure and Optical Properties

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Abstract. In recent years, there is a gradually increasing interest in pulsed laser annealing (PLA) as a known and promising technique suitable for crystallization of amorphous hydrogenated silicon films, in order to improve their structural and optical properties. The main advantages of laser annealing are compared to other conventional annealing techniques. The irradiation of a material with a laser beam causes a rise of the sample's temperature at high values only inside the irradiated volume. High power, short pulse duration and short wavelength make it possible to heat the films to high temperature within a very short time, without introducing thermal damage to non-heat-tolerant substrates. This gives the possibilities of spatial selective crystallization or obtaining of bi-phase (both *a*-Si/*poly*-Si or *a*-Si/*nc*-Si) films and are main advantages of this technique used in the field of photovoltaic and electronic devices.

In this paper, the investigation of relationship between KrF excimer laser 248 nm post-deposition annealing (laser input power density) and structural and optical properties of treated silicon thin films is reported. The bonding configuration, hydrogen evolution, microstructural and optical changes of excimer laser treated silicon thin films under air and room temperature ambient were studied by absorption and vibration spectroscopies. An original series of hydrogenated amorphous silicon (*a*-Si:H) thin films were synthesized by a capacitively-coupled radiofrequency (13.56 MHz) plasma enhanced chemical vapor deposition (PECVD) method using silane (10% SiH_4 diluted in Ar) as precursor gas. These 600 nm thin films were prepared on Corning glass and Si(100) substrate at deposition rate of 37 nm/min and low substrate temperature of 250°C. Subsequently, all as-deposited films were annealed by Krf excimer laser 248 nm to initialize film recrystallization. Different laser input power density up to 150 mJ/cm^2 for one shot was used. The effect of laser-induced crystallization of amorphous silicon films on properties of these films was systematically studied. The experimental results from UV-Vis spectrometry, FT-IR and Raman spectroscopies are presented and discussed. The optical band gap of the layer material decreases after laser treatment. Using laser pulses of different energy we obtained two-phase films with different crystalline volume fraction up to 80%. The structural changes and the crystallization behavior were investigated as a function of laser input power density.