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Plasma polymer multilayers of organosilicones and their optical properties controlled by RF power

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Plasma-polymerized organosilicones constitute a class of materials with a rich and varied scientific background. This class of materials possesses a special characteristic, which distinguishes it from other plasma polymers – the ability to vary and control the degree of its organic/inorganic character (i.e., the carbon content) by the appropriate choice of fabrication variables. This allows one to control many physicochemical properties over wide ranges resulting in an extraordinary potential for useful applications, which are only now beginning to be tapped. The organosilicon plasma polymers are widely recognized for their potential not only in electronics and optoelectronics, but also in fiber reinforced or particulate composites and nanocomposites with controlled interphase. Plasma-polymerized tetravinylsilane (pp-TVS) films were deposited on polished silicon wafers (100) using plasma-enhanced chemical vapor deposition (PECVD, 13.56 MHz). The substrates were pretreated by argon plasma (10sccm, 5.0Pa, 5 W) for 10min to improve the film adhesion. The pp-TVS films were prepared at a mass flow rate of 3.8sccm (3.0 Pa) and the power ranging from 10 to 70 W varying the film thickness 25 nm – 1 μm. A phase-modulated spectroscopic ellipsometry was employed to analyze the single film using a model with classical oscillator dispersion in the spectral range 250 – 830 nm. The thickness and dispersion of the refractive index and extinction coefficient were determined for the corresponding film. We found out that optical parameters of deposited films are controlled by RF power and the band gap can be varied from 1.2 to 2.0 eV. The refractive index (633 nm) and the extinction coefficient (250 nm) was 1.69 (0.18) at 10 W and increased to 2.08 (0.40) at 70 W, respectively. Next, well-defined multilayered films were deposited from tetravinylsilane combining individual layers polymerized at different powers. A realistic model of the multilayer structure was used to analyze ellipsometric data and distinguish individual layers in the multilayered film, evaluate their thickness and optical constants. Dispersion dependences for the refractive index were well separated for each type of individual layer, if the thickness was decreased 500 – 25 nm, and corresponded to those of the single layer.

Keywords
multilayer
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ellipsometry
refractive index
extinction coefficient