Thickness dependence of refractive index of Ag-PVA plasmonic nanocomposites

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One-pot synthesis of polymer films embedding noble metal nanoparticles has many applications due to its relative simplicity. In this study, nanocomposites made of polymer films embedding silver nanoparticles were prepared by thermal annealing of poly-(vinyl) alcohol films containing $AgNO_3$. Low (2.5 % w :w) and high (25 % w :w) doping concentration of silver nitrate were considered as well as their effect on the optical properties of thin (30 nm) and thick (300 nm and more) films.

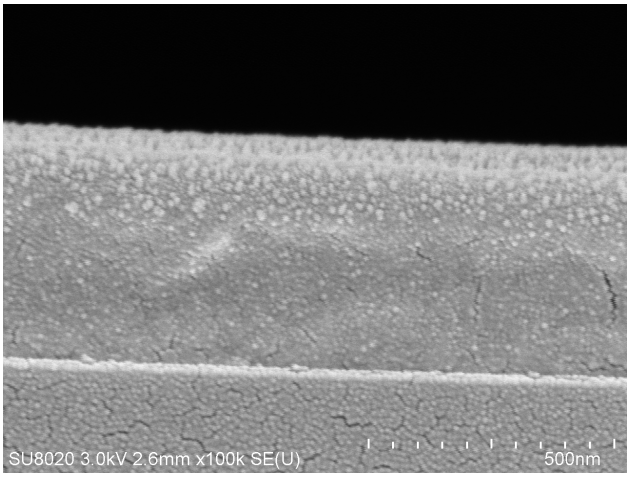

Fig. 1 – Gold-sputtered cross-section of a 450nm-thick PVA film (Ag doping : 25%)(Scalebar : 500nm).

The topography and the optical properties (refractive index n and extinction coefficient k) of such films were studied by SEM, atomic force microscopy and spectroscopic ellipsometry. A representative cross-section of a polymer film spin-coated on silicon is given in Fig. 1. Starting from the same Ag-doped solution and for a given doping level, the refractive index of the nanocomposite appears to be thickness-dependent and clearly function of the spin-coating parameters. In both cases, the extinction peaks are quite similar although slightly shifted and broadened but, even off resonance, the real parts of the refractive index remain very different. Plasmon peak position, width and amplitude were studied over more than 90 samples. Multivariate statistical analysis techniques (principal component analysis and support vector machines) were used to enhance the differences in the optical behavior of the thick and thin films.

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