STUDY OF OPTICAL AND STRUCTURAL PROPERTIES OF SiO$_2$ OPALS INFILTRATED WITH Sb$_2$S$_3$ NANOPARTICLES

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The photonic crystals (PC) are novel materials with promising applications in optoelectronics, as well as biological and chemical sensor. The synthetic opal of silica (SiO$_2$) is a good PC because it is simple to build and their structures can be useful in visible and near infrared wavelength range. Because of its low refractive index contrast (SiO$_2$: ~1.4), a full photonic band gap (PBG) cannot be expected. In order to improve the PBG properties, the SiO$_2$ opal structures can be infiltrated with high refractive index material such as stibnite (Sb$_2$S$_3$) which has a refractive index as high as 3.8. In the present work we have reported a simple technique for the infiltration of SiO$_2$ opals with Sb$_2$S$_3$ precursor solution, placing the stibnite nanoparticles into the face-centered cubic interstitial sites. A number of infiltrated SiO$_2$ opals were prepared by varying the concentration of antimony sulfide precursor solution as well as the duration of infiltration. A post annealing process has been employed in order to convert the amorphous Sb$_2$S$_3$ into crystalline form. Scanning electron microscopy (SEM) was used to confirm successful infiltration of SiO$_2$ opals with antimony sulfide. The change in structural, optical and vibrational properties of SiO$_2$ opals before and after infiltration with Sb$_2$S$_3$ was followed by X-ray diffraction, Raman scattering analysis, diffuse reflectance and infrared spectroscopies. The results indicate that a fine tuning of photonic crystal properties has effectively been achieved. Work in the direction of constructing the inverse opals of Sb$_2$S$_3$ is under progress.

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