**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI**
**SHORT ABSTRACT OF THESIS**


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Programme of Study : Ph.D.


Thesis Title: **Studies on Linear and Non Linear Optical Properties of Pulsed Laser Deposited Si, $SiO_x$ and SiC Nanostructured Thin Films**


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## SHORT ABSTRACT


The present research work was aimed towards the fabrication and characterization of nc-Si, $SiO_x$ and SiC films via PLD technique. The effect of substrate temperature and background gas pressure on their stoichiometry, crystallinity, linear as well as nonlinear optical (NLO) and photoluminescence (PL) properties of these films are studied in detail.

The PLD nc-Si thin films were comprised of nc-Si domains embedded in a-Si matrix. The crystallinity as well as optical properties were observed to be influenced by $T_s$. The $SiO_x$ films exhibited change in stoichiometry, x=0.03 to 2.1, as a function of oxygen pressure ($10^{-4}$ to 0.5 mbar). These films exhibited the micron-sized clusters containing nc-Si embedded in uniform background composed of oxidized amorphous Si. The band gap energy was blue shifted from ~ 1.55 to 2.80 eV with increasing $O_2$ pressure. Laser excited PL spectra with multi-component peaks originated due to quantum confined nc-Si as well as oxygen related defects; NBOH and $V_o$ centers, were observed for oxygen rich $SiO_x$ films. Amorphous SiC exhibited a transition from Si-rich SiC to nearly stoichiometric SiC with the increase in $T_s$ (RT to 750 °C) which resulted in decrease in the $n_o$ from 3.00 to 2.64 and blue shift in the optical band gap from 1.59 to 2.33 eV. The structural disorders in these films tend to decrease with increasing $T_s$.

The third order NLO characteristics of Si, $SiO_x$ and a-SiC was performed by modified Z-scan set up using cw He-Ne laser. All the three varieties of thin films showed strong reverse saturation absorbtion and self focusing property corresponding to positive nonlinear refraction originating from thermo-optic effect. The values of third order optical suceptibility, $\chi^{(3)}$, in $SiO_x$ was observed to be varying from $10^{-1}$ to $10^{-3}$ esu with increasing oxygen content while for that of nc-Si and a-SiC films was ~ $10^{-1}$ *esu* and $10^{-3}$ esu, respectively. $\chi^{(3)}$ was observed to be proportional to linear absorption of films. The optical limiting (OL) property was exhibited by the nc-Si and $SiO_x$ thin films where the OL threshold varies inversely with *ß*.

Finally, the nanostructures of Si were locally grown on Si wafer by direct laser ablation of c-Si wafer in air. The laser ablation resulted in the formation of crater, containing crystalline central region surrounded by the micron sized cauliflower-like clusters of a-Si:$SiO_2$. They exhibited PL in far red region originated from nanostructured a-Si and NBOHC defects.