Chapter 8

Summary and Conclusions
Summary of the work

Porous composite (CaO-SiO$_2$) ceramic nano material Wollastonite (CaSiO$_3$) has been synthesized by a novel low temperature initiated, self-propagating and gas producing Solution Combustion process. This method is simple, fast and economical. Greater pure and homogeneous materials result from this process and can lead to improved electrical and optical properties. Polycrystalline CaSiO$_3$ (Wollastonite) ceramic powder synthesized by solution combustion route exhibits a single $\beta$-phase when calcined at 900°C for 3 hours in the nano-regime with a particle (crystallite) size of 20-30 nm. Thus it attains the single phase at lower temperatures compared to that prepared by conventional ceramic method.

The synthesized CaSiO$_3$ ceramic possesses a quite high dielectric constant (57 at 1 MHz), low dielectric loss and very low dielectric conductivity of the order of $10^{-10} - 10^{-6}$ mho cm$^{-1}$ in the frequency range $10^2 - 10^6$ Hz. $\beta$-irradiation of nano wollastonite shows thermoluminescence properties. The thermoluminescence glow curves are produced at higher temperatures compared to other phosphors. The Pr-doped CaSiO$_3$ nano ceramic shows ‘colossal dielectric constant’ at lower frequencies, due to heterogeneous electrical microstructure which has been analyzed by impedance spectroscopy and Cole-Cole plots.

The dielectric properties of the nano-wollastonite can be enhanced by doping rare earth ions of higher oxidation number of proper ionic radii, which is analyzed by the ‘tolerance factor’ concept. Addition of Pb acts as a sensitizer for photoluminescence by Mn ion. The CaSiO$_3$:Pb, Mn also shows good thermoluminescence property.
Conclusions

It may be concluded from the investigations carried out and presented in this thesis that

- Solution combustion method is a straightforward and easy method of synthesis of ceramic powders in the nano regime. Calcination can be done at much lower temperature compared to solid state reaction method.

- Irradiation of nano ceramic powders can be an useful technique to tailor the dielectric properties of the wollastonite.

- Investigated nano ceramic can also be employed as a radiation detector in dosimetric measurements at higher temperatures.

- Observation of high dielectric constant in the doped system implies that the material is similar to CCTO (Calcium Copper Titanium Oxide) and can be employed as an IBLC (Internal barrier layer capacitor) which is used as a passive component in electronic circuits.

- Higher oxidation number rare earth ions (of proper ionic radii) doped nano CaSiO$_3$ ceramics show higher value of dielectric constant and can be employed in the miniaturization of capacitive elements in the electronic circuits.

- The Pb, Mn doped CaSiO$_3$ in the bulk form is already in commercial use as a red-phosphor. Its photo luminescence properties can be enhanced in the nano regime.