CHAPTER 7:

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In the present work, $Li_4Ti_5O_{12}$ has been successfully obtained via the sol-gel method. The predicted mechanism of $Li_4Ti_5O_{12}$ formation shows that Li_2TiO_3 is also present. This is confirmed through XRD studies. $Li_4Ti_5O_{12}$ is thermally stable above 700 ^{o}C. XRD studies indicate that $Li_4Ti_5O_{12}$ is cubic. The lattice parameter is approximately 8.3 Å for all $Li_4Ti_5O_{12}$ samples produced at different sintering temperatures and times. This work has also established of $Li_4Ti_5O_{12}$ as an anode material for lithium ion batteries. The charge-discharge profiles show a voltage plateau at ~1.5 V which is due to oxidation and reduction of Ti^{3+}/Ti^{4+}. The discharge capacity is ~60 mAh g^{-1} for 20 cycles implying that during intercalation and de-intercalation processes only one electron is inserted and de-inserted in the electrodes. The low discharge capacity is attributable to the semi-amorphous nature of the $Li_4Ti_5O_{12}$ compound.

It is a task in this work to understand the effect of $Li_4Ti_5O_{12}$ on the dielectric properties of PVA/$Li_4Ti_5O_{12}$ composites. Solutions of PVA in 1 % acetic acid have been added with different amounts of $Li_4Ti_5O_{12}$ stirred and cast to form films. From the XRD patterns, semi-crystalline phase of PVA is reduced as the amount of $Li_4Ti_5O_{12}$ increased, but the crystallinity of the composite increases with increasing $Li_4Ti_5O_{12}$. From the FTIR spectra, the shift in C=C stretching band is observed indicating complexation between polymer and the oxides. The incorporation of $Li_4Ti_5O_{12}$ is also observed to shift the absorption edge of the composite. The addition of $Li_4Ti_5O_{12}$ makes the surface morphology of composite to appear coarse with agglomerates of $Li_4Ti_5O_{12}$. The dielectric relaxation is typically viscoelastic relaxation.

These characteristics are considered to influence the dielectric properties of PVA/$Li_4Ti_5O_{12}$ composite. The composite exhibits low dielectric constant as compared to that of PVDF/$BaTiO_3$. At high frequencies, the dielectric constant is even lower indicating weak control of the material over charge storage.

As suggestion to continuing future works, different raw materials maybe used in the preparation of $Li_4Ti_5O_{12}$ by the sol-gel technique. Perhaps cheaper raw materials can be utilized. As a “pre-formation step”, it maybe wise to pre-heat the precursor at temperatures of 600 ^oC or less for a period of time say two hours. From TG analysis, $Li_4Ti_5O_{12}$ has not yet formed but this pre-formation treatment could have partially formed the desired compound. Then on sintering at temperatures above 700 ^oC a more crystalline product could be formed and a lithium-ion battery with higher capacity could be achieved.

As a second suggestion, it may be worth considering adding $Li_4Ti_5O_{12}$ into a solution of PVA in water since the dielectric constant of PVA film with water as solvent is higher than that of PVA dissolved in 1 % acetic acid solution. It is expected that the dielectric constant would increase when $Li_4Ti_5O_{12}$ is added to the solution PVA in water. It is also expected that the dielectric constant would increase.