CHAPTER-VI

CONCLUSION

Indium doped Tin Oxide: MWCNT composites, Vanadium doped Indium Oxide: MWCNT composite and Indium and Vanadium doped Tin Oxide: MWCNT composite, were prepared using simple chemical solution method. The prepared composites were irradiated by microwave radiation and sonicated using an ultrasonicator. A comparative study was made between as-prepared, microwave assisted and sonicated samples. The samples were characterized by SEM, HRTEM, XRD, UV-Vis spectrometer, Laser Raman, Photoluminescence and the gas sensing properties of the sample to reducing gases was analyzed.

The X-ray diffraction of the samples concludes that the crystalline size varies due to the impact of microwave assistance and sonication. The structural parameters like FWHM, particle size, lattice parameters were determined for all the samples which were in good agreement with the standard JCPDS data and there was no shift in phase due to microwave irradiation or sonication. It was found that there was decrease in particle size and increase in crystallinity in few samples due to the impact of microwave radiation when compared to as-prepared samples.

The morphological studies done by using SEM and TEM confirms the mixture of metal oxide and dopant coated on the surface of the MWCNT. The SEM images gave a clear picture that the material is coated on the surface of MWCNT which leads to the increase in the diameter of the coated tubes and confirms the surface modification. The TEM images give a high resolute image of the material coated on MWCNT. It also confirms the increase in diameter when compared to the uncoated MWCNT.

The EDAX spectrum confirms the presence of dopants, metal elements, and oxygen which was coated on to the surface of MWCNT. The UV absorption spectrum indicates the material’s ability to absorb UV light by the occurrence of a strong peak around 300 nm. There was a shift in the absorption curve for all the microwave and sonicated samples compared to the as-prepared samples which indicates that microwave radiation and sonication has impact on the structural parameters leading to the variation in absorption edge.
The Laser Raman spectrum confirmed the presence of D-band and G-band in all the samples. It was found that the intensity of the bands varied with microwave irradiation and sonication. The ratio of intensities of defect band and graphitic band was calculated. The photoluminescence spectra of the samples exhibited various bands which are in agreement with the previously reported literatures. The photoluminescence spectra confirm that the composites had the emission in the blue-green wavelength region, is attributed to the oxygen deficiencies, vacancies and interstitials present in the samples.

All the samples showed a variation in resistance on exposure to a low trace of Carbon dioxide at room temperature. The samples showed a decrease in resistance on exposure to 100 and 200 ppm of Carbon dioxide. This indicates that the composites are promising materials for the development of Carbon dioxide gas sensors capable of sensing low traces at room temperature. The difference in gas sensing property i.e. variation in resistance was found to change due to the impact of microwave radiation and sonication. The microwave assisted Indium doped Tin Oxide: MWCNT composite exhibited a short response time and recovery time when compared to as-prepared and sonicated sample on exposure to 100 ppm and 200 ppm of CO₂ gas, which confirms the impact of microwave irradiation in increasing the nucleation rate. The variation in resistance for the microwave assisted and sonicated Indium and Vanadium doped Tin Oxide: MWCNT composites were found to be high, compared to as-prepared sample, which is the source for generation of electrical signal for a gas-sensor. The response and recovery time for microwave radiated sample was less, compared to sonicated sample. Microwave assisted Vanadium doped Indium Oxide: MWCNT composites exhibited short response and recovery time, compared to as-prepared and sonicated sample, which confirms the effect of microwave radiation on reaction time leading to short response and recovery time of the sensor. In future, an extensive work can be carried out using Carbon nanotubes, a promising material, by varying the dopants, metal oxides and parameters like temperature which changes the sensitivity, selectivity, response and recovery time on exposure to different trace level reducing or polluting gases at room temperature.