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Title of Thesis: **Nano Structured Conducting Polymers and their Applications**

Abstract

Conducting polymer is that class of polymers which can conduct electricity through itself. The concept of conductivity in polymers can be explained on the basis of π-conjugated charge carriers where conduction mechanism is explained on the basis of solitons, polarons and bipolarons. In the present thesis work the conducting polymer on which studies has been carried out for ammonia sensor application is polyaniline (PANI) which is doped with dodecyl benzene sulphonic acid (DBSA).

The work presented in this thesis is mainly focused on the application of nano structured PANI-DBSA as NH_3 gas sensor and its molecular dynamics. The advantage of using nano structured PANI is that it offers the reduced inhomogeneity of the surface morphology of PANI and increased surface to volume ratio which avails the easy pathway to the charge carriers. Thus, adding large number of nano structured PANI means availability of surface area for target gas molecules. This leads to the enhanced sensing properties of PANI-DBSA thin film for NH_3 gas.

The work based on functionalized multiwall carbon nanotubes (f-MWCNT) and PANI-DBSA nano structured composite has shown high sensitivity for NH_3 gas. The thin film of f-MWCNT-PANI-DBSA nanocomposite was deposited on glass substrate having platinum interdigitated electrodes. The composite thin film based gas sensor exhibits enhanced and fast response for ammonia (NH_3) gas in comparison to

bare PANI-DBSA based sensor at room temperature. The response of nano structure composite based sensor to other gases (i.e. H_2, CO_2, LPG, CO, SO_2 and CH_4) is poor even at high concentration (500 ppm) of these gases showing good selectivity at room temperature. But the sensor reveals enough good sensitivity from 0.1 to 500 ppm concentration of NH_3 target gas. The enhancement in sensitivity response of composite sensor is due to various obvious interactions of f-MWCNT with PANI-DBSA composite which avail the larger surface area to the exposure of target NH_3 gas.

The exposure of NH_3 gas on the conducting PANI-DBSA thin film increases the resistance of film from kilo to mega ohm which clearly reveals the transition of conducting nature to insulating one. This transition of film gives the possibility of development of dipoles in the system and due to which there could be a kind of relaxation process in the material. The highly conducting PANI-DBSA polymer has been studied in the absence and presence of NH_3 gas by dielectric spectroscopy in the frequency range from 20 Hz to 10 MHz. The dielectric spectroscopy has been performed to study the dielectric relaxation behavior of DBSA doped PANI nano-composites polymer thin film. When the bare film is studied in this frequency range then real part of complex dielectric permittivity at low frequency has been found negative which is the characteristic property of high conducting material. On exposure of film to NH_3 gas, the permittivity become positive and shows the behavior of a dipolar material. The theoretical fitting of the experimental results has been found to obey the Cole-Cole model for dipolar dielectric materials. Moreover, the time dependent studies show the shift of relaxation frequency towards higher one as a function of increase in exposure time. This clearly suggests that the insulating dielectric character is increasing with enhanced dipolar strength.