Abstract

The work on comparative study of spin coated, plasma treated and plasma polymerized based capacitive / resistive type humidity sensor is reported in this thesis. PolyMethyl Methacrylate (PMMA) is selected for the study.

The thesis is divided into 5 chapters.

Chapter 1 introduces the topic of research with necessary background. It also gives the review of Humidity Sensors which consist of basic definitions of humidity (Absolute Humidity, Specific Humidity and Relative Humidity), methods for creating humidity (Use of saturated salts, Divided Flow method, Two Pressure Method, Two Temperature Method etc.), humidity sensing methods (resistive /capacitive) and sensor fabrication technologies (thick film, thin film, dip coating, spin coating etc.).

Ceramic or polymeric materials are used for humidity sensing. Polymer material PMMA was selected for study. Review of the work reported in the literature on relevant topics is carried out and presented. The material was deposited on glass/silicon/glass epoxy (containing interdigited electrodes) substrates using spin coating and plasma polymerization process. The spin coated films were also treated by plasma. These three types of deposited materials were studied for humidity sensing and their performances were compared. Aim of the work and objectives are spelt out at the end of the chapter.

Chapter 2 describes the different experiments carried out for deposition of material (spin coating, plasma polymerization and plasma treatment). Thicknesses of the films were measured by gravimetric method or taly step method. Structural characterization of the material is done by using FTIR and morphological observations were done with SEM. Humidity response of the films is taken using two methods - continuous RH response (resistance measurement) and static step RH response (capacitance measurement). Variation of optical parameters, especially transmission, with humidity was studied using the home made system. Sensor parameters such as sensitivity, response time and recovery time were measured.

In Chapter 3 results obtained on the humidity response (sensitivity, response time and recovery time) of the spin coated, plasma treated and plasma polymerized thin films of PMMA are given and discussed in the light of basic theory and the results reported in the literature. The response is measured in terms of change in capacitance as a function of humidity.

Spin coated PMMA films of various thicknesses are reported. Spinning speed and viscosity (concentration) of PMMA solution were varied for obtaining films of various thicknesses. FTIR of the deposited films was taken to confirm PMMA deposition. Response time and recovery time were determined for some of the films. The obtained variation in humidity response is discussed on the basis of structure of material and /or basic structure of the sensing device.

Chemical structure of the film has an effect on humidity characteristic of the films especially sensitivity and hysteresis. Attempt was made to modify the structure of the film by
plasma treatment on the surface of the spin coated films. Chapter 3 also describes the results and discussion on the plasma treatment of the spin coated films. Argon gas was used for the treatment. RF power and treatment time were varied. Changes in the structure of the films were found out using FTIR and SEM techniques.

Plasma polymerization is another method of modifying the structure of the film. The effect of change in structure on the sensing characteristics is also studied and reported in this thesis. The plasma polymerization was carried out in homemade system. Thicknesses of the films were measured using taly step method. In this method MMA monomer was used for deposition. The degree of polymerization can be changed by changing the deposition parameters such as gas pressure, monomer flow rate, argon gas flow rate, deposition time and RF power. These parameters were varied to get films of different structure. FTIR spectra were taken to determine the structure of the films. These films were then used to determine their sensitivity, response and recovery time. The results obtained are compared amongst themselves and also with the ones available in the literature.

Chapter 4 describes optical response study of PMMA to humidity. For this study films were obtained by drop casting and spin coating deposition methods. Thicknesses of the films were measured using gravimetric method. The films obtained were used for optical response study. The results on humidity response are given and discussed. It also states the concluding remarks.

Chapter 5 summarizes the work done and proposes the future plans.