Chinese Chemical Letters Vol. 12, No. 8, pp 701 – 702, 2001

A Novel Thin Film Resistive Humidity Sensor Based on Soluble Conjugated Polymer: (propionic acid)-co-(propargyl alcohol)

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Abstract: A novel soluble conjugated copolymer (propionic acid)-co-(propargyl alcohol) (PA-co-OHP) has been synthesized for the first time using a new palladium acetylide catalyst $Pd(PPh_3)_2$ $(C{\equiv}CC(CH_3)_2OH)_2$ (PPB). Thin film resistive humidity sensor based on the copolymer doped with $HClO_4$ was prepared. The impedance of the sensor changed from 10^3~10^7 Ω in 95%~30%RH, and the response of that is very quick (<6 sec.). Preliminary results show the copolymer is a promising humidity sensitive material.

Keywords: Humidity sensor, conjugated polymer, propiolinc acid, propargyl alcohol.

In recent years, humidity sensors have found wide applications in industrial and agricultural production, process control, household electric appliances, *etc*., therefore the research on humidity sensitive materials has attracted more and more attentions, and many polymers, including polymer electrolytes, conjugated polymers have been investigated as sensing materials[1-3]. However the doped conjugated polymers in general were insoluble and can not be used to prepare thin film humidity sensors, which greatly hindered further research and their practical applications. In this paper, a soluble doped copolymer (propionic acid)-co-(propargyl alcohol) (PA-co-OHP) was obtained. A novel thin film resistive humidity sensor based on the copolymer doped with $HClO_4$ was prepared and shows high sensitivity and quick response.

The palladium acetylide complex catalyst $Pd(PPh_3)_2$ $(C{\equiv}CC(CH_3)_2OH)_2$ (PPB) was prepared as described in literature[4]. Synthesis of the copolymer was as follows: the solution of 32 mg PPB, 212 mg propionic acid, 172 mg propargyl alcohol in a mixed solvent (THF:methanol=1/1 in volume ratio) stood under purified N_2 atmosphere at 60°C for 7 h. A dark brown solution was obtained, then precipitated in the mixture of *n*-hexane and ether (1/1 in volume ratio), filtered, washed with precipitants, and dried under vacuum for 24 h, giving a brown powder with about 60% yield. The polymer is soluble in THF/methanol mixed solvent and DMSO, and has a M_n and M_w of ~1100 and 1600, respectively. Doping was carried out by mixi~~ng~~ the ~~sol~~ution of polymer in THF/methanol mixed solvent with $HClO_4$ in THF. The doping solution was deposited on an interdigital (IDT) gold electrode by spin coating to prepare a thin film resistive humidity sensor. The humidity sensitive characteristics of the sensor was tested under dynamic conditions in a home-made cell equipped with a commercial humidity sensor,

and the impedance measurements were done by a Solartron 1255 FRA apparatus.

Figure 1 Humidity response of sensor based on PA-co-OHP doped with $HClO_4$

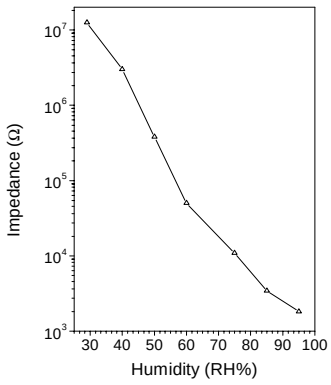
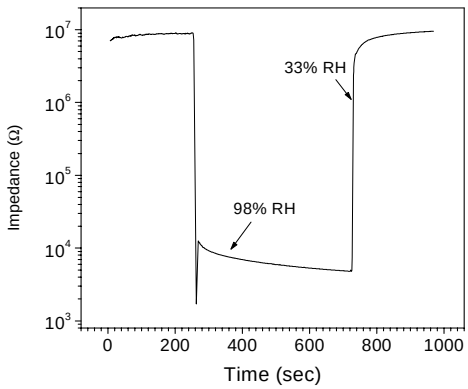


Figure 2 Response of sensor between different humidities



The humidity response of the sensor based on the copolymer doped with $HClO_4$ was shown in **Figure 1**. The impedance of the sensor changed almost four orders of magnitude (10^7~10^3 Ω) with humidity in 30~95%RH, showing high sensitivity, and the logarithimic plot exhibits good linearity. **Figure 2** was the response of the sensor between high and low humidities. It is clearly seen that the impedance of the sensor quickly reaches constant value in both absorption (33% to 98% RH) and desorption (98% to 33% RH) processes, giving a response time of less than 6 seconds (98% to 33% RH). Furthermore, the doped copolymer is soluble and can be used to prepare thin film sensor easily, which is a great advantage for practical application. All these results indicate the copolymer PA-co-OHP is a promising humidity sensitive material.

Acknowledgments

This project was supported by the National Natural Science Foundation of China and Zhejaing provincial Natural Science Foundation, and by the Scientific and Technological Agreement between China and Italy. The authors thank Dr. G.Casalbore-Miceli and Dr. N. Camaioni for help in measurement of humidity characteristics.

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Received 20 January, 2001