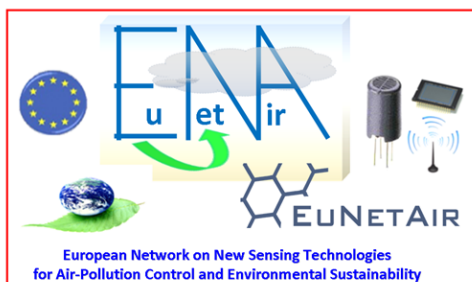


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BOOKLET

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CHEMIREISTIVE VOC SENSOR MATERIALS BASED ON SILICONE RUBBER COMPOSITES

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Abstract

At many places like factories, chemical waste dumps, underground storage tanks workers every day is exposed to volatile organic compounds (VOC). That is one of the reason why is needed accurate characterization and long-term monitoring to reduce health risks and ensure public safety. However, current detection methods, like gas chromatography, ion mobility spectrometry and quartz microbalance are costly and time-consuming [1]. There is need for inexpensive, low-powered, fast recovery and repeatable sensors, that's why different polymer matrix materials and fillers have been used to achieve these goals. Aim is to make polymer composite-absorption based sensor that indicates a change in relative electrical resistance when exposed to (VOC). Silicone rubber has been chosen as matrix material, because it has better weathering and aging resistance, and chemical stability comparing to ordinary organic rubbers.

Highly structured carbon black (CB) and short multiwall carbon nano-tubes have been used as filler material in the composite. Homogenous composite mixture of nanofiller and silicone rubber was coated on crystalline glass-ceramic substrate with aluminum electrodes by dip coating method. Composites were cross-linked by changing vulcanization pressure. Crosslinking time, temperature and atmosphere were maintained constant. Inert gas, nitrogen, atmosphere was chosen to reduce the possibility of peroxide to inhibit. During crosslinking the composite electrical resistance was measured as indicator of composite system electric network formation.

It was found out that the composite steady state electrical resistance significantly reduces, when temperature (~ 180°C) and pressure is applied. Silicone composite viscosity during vulcanization reduces. These are favorable conditions for filler aggregates to rearrange and form conductive network. Electric resistance stabilization at the end of crosslinking approves composite system electric network formation. Experiments carried out shows that pressure applied during vulcanization changes the sample steady state electric resistance after curing.

After curing the Fourier transform infrared spectroscopy (FTIR) was used to evaluate chemical bond changes, which could approve that crosslinking reactions are completed. Using FTIR chemical bond changes was measured. Fluctuations that are inherent polydimethylsiloxane, like -Si-(CH₃)₂ (1260; 865-750 cm⁻¹), Si-O-Si (1130-1000 cm⁻¹) and others has been detected. Absorbance of various chemical bonds changes when during crosslinking applied pressure is changed. Applying higher pressure, absorbance of chemical bonds that approve that crosslinking reactions has been completed, like CH=CH₂ (1410 cm⁻¹) stretching, reduces. Silicone reaction with nitrogen atmosphere also has been shown in the spectrum. N=O (1460-1440 cm⁻¹) bond shows that crosslinking reaction probably are not fully completed, because part of peroxide has been neutralized by nitrogen [2].

Relative electrical resistance change of silicon rubber composites was measured, when the composite samples were exposed to different concentrations of non-polar toluene vapours. Nitrogen as carrier gas was used during all experiment time. Fast recovery of the composite electrical resistance has been noticed, when the composite are not in contact with toluene.

Figure 1 shows that the sample containing CNT relative electrical resistance is twice larger than CB. Grate advantage for silicone composites is fast recovery of electrical resistance when the composite are not in contact with toluene. Recovery speed remains also at different concentration of toluene.

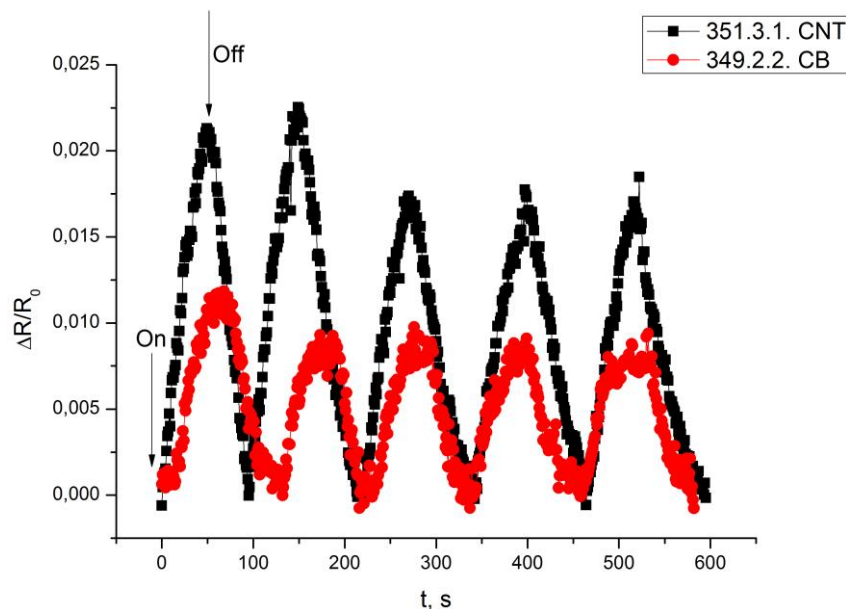


Figure 1. Relative electrical resistance change of silicon rubber composites in non-polar toluene vapours (800 ppm) containing short multiwall carbon nanotubes (CNT) and 349.2.2. highly structured nanocarbon black (CB).

References

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