Volatile Organic Compounds Detection within Gaseous Mixtures

Gita Sakale, Elina Liepa and Maris Knite (*Riga Technical University, Institute of Technical Physics*)

***Keywords* – nanostructured carbon composites, chemoresistive sensors**

I. Introduction

Volatile organic compounds (VOC) are markers that can indicate about spoilage of food and beverages, microorganism activity in foodstuff or other biological medium. Therefore selective sensor materials are elaborated and their capability to sense the presence of VOC evaluated. Detection of specific VOC in a gaseous mixture, which contains a mix of different VOC and has high relative humidity as well, is rather complicated. Usually gaseous mixture analyses are done by gas chromatography/mass spectroscopy. Here sensor materials based on polymer-nanostructured carbon composite (PNCC) are presented for in-situ registration of generated VOC.

II. Conception of Experiments

Sensor material is a composite film made of matrix and electroconductive filler. As matrix material is used polymer (polyisoprene as well as polyvinylacetate), but as filler – carbon nanoparticles or multiwall carbon nanotubes. PNCC sensor materials are prepared gradually increasing filler concentration till stable electroconductive grid within the matrix is formed. It means that the addition of filler changes the composite electrical properties and the composite from insulator become electroconductive. Besides that the composite conductivity is governed by tunneling currents in thin layer of matrix between carbon nanoparticles.

When the composite is exposed to VOC its electrical resistance increases noticeably. Electrical resistance increase is a result of VOC induced matrix swelling, distances between carbon particles increase and tunneling currents decrease.

III. Experimental

Polyvinylacetate-nanostructured carbon composite (PVAc-NCC) and polyisoprene-nanostructured carbon composite (Pi-NCC) production technology is described elsewhere [1]. Sensitivity to VOC is determined by exposing sensors for certain time to VOC and registering at the same time the electrical resistance of the sensor with Agilent 34970A acquisition switch unit.

IV. Results

Relative electrical resistance changes of both Pi-NCC and PVAc-NCC in time, when sensors are exposed to diverse VOC, are shown in Fig.1 and Fig.2. Diversity of VOC is controlled by VOC dielectrical constant (ε). As larger the value of ε, the more polar like the VOC is. Obtained results indicate that Pi-NCC has higher sensitivity to non-polar like VOC, but PVAc-NCC is more selective to polar VOC. For both composites the effect is reversible that means, when sensors are removed from VOC, electrical resistance decreases to the initial value. So the sensor materials can be used repeatedly.

VOC detection in gaseous mixture by PNCC also has been performed. As there is an interest for only specific VOC detection then the rest part of gaseous mixture is a background in form of relative humidity, mixture of other VOC and gases. Gaseous mixture background can considerably diminish or increase sensor material electrical response to specific VOC.

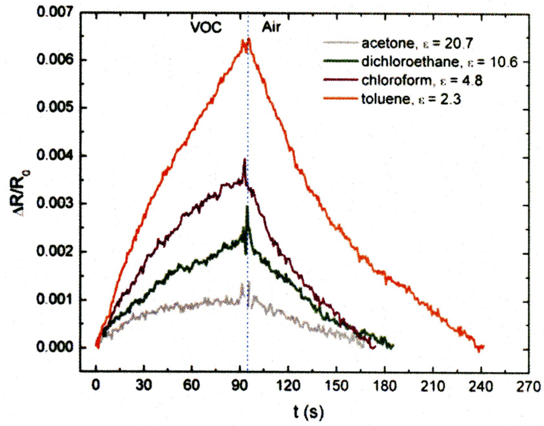

Fig. 1. Pi-NCC relative electrical resistance change versus time, when sensor material exposed to VOC (acetone and chloroform concentration 500ppm, toluene and dichloroethane - 200ppm).

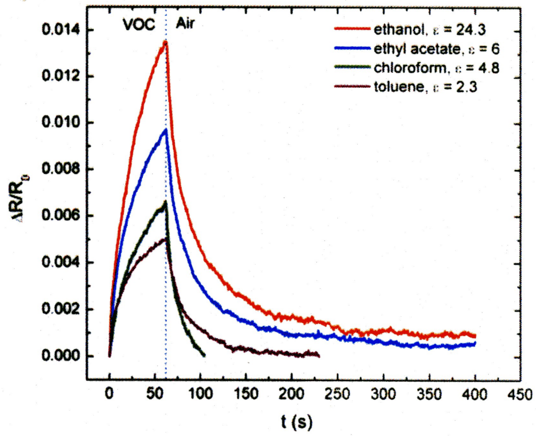

Fig. 2. PVAc-NCC relative electrical resistance change versus time, when sensor material exposed to VOC (VOC concentration 500ppm).

V. Conclusions

Elaborated and produced PNCC are selectively sensitive to the presence of VOC. Electrical resistance of the composite increases noticeably, when sensors are exposed to VOC. PNCC are perspective sensor materials to be applied for in-situ VOC detection in gaseous mixtures.

V. References

[1] G.Sakale et.al., Atmosphere control by chemoresistive polymer composites, Proceedings of the 8th International Conference on Informatics in Control, Automation and Robotics, 2011, 370-375. pp.