PRINTED ORGANIC COMPOSITES FOR OPTO–ELECTRONIC GAS SENSOR ARRAYS

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ABSTRACT

The development of new materials for gas sensing is of great interest in, for example, industrial, bio-medical or safety applications such as quality control of food-stuffs, health monitoring or detection of hazardous substances in the atmosphere. Furthermore, deposition techniques such as inkjet printing offer a facile and reliable way to fabricate sensors. In the course of the research for this thesis, various materials for optically and electrically transduced gas sensors have been developed, characterized and used to fabricate sensors by inkjet printing. The prepared materials include combinations of metal phthalocyanines (MPc) and metal porphyrins with sol-gel derived transparent matrices, hybrid materials of MPc/MP graphene prepared by electrolytic exfoliation of graphite and ternary MPc–graphene–polyaniline nanofiber (PANI NF) composites. Materials were characterized by optical, scanning electron, transmission electron and atomic force microscopy as well as UV-Vis, FTIR and Raman spectroscopy. Chrystal structure of MPc-graphene was investigated by X-ray diffractometry. Optical and electrical gas sensing tests with numerous analytes confirmed the abilities of the prepared sensors to respond in terms of UV-Vis absorbance and electrical resistance changes upon interaction with analytes. By recording the UV-Vis spectrum of the samples over the time of sensing tests and dividing the spectra into several wavelength ranges, it was possible to successfully emulate sensor arrays for analyte discrimination. This was achieved by analysing acquired data-sets by principal component analysis and hierarchical cluster analysis. Results show that classification of the employed analytes could be achieved. In particular, sol-gel films containing zinc tetraphenyl porphyrin (ZnTPP) and composites of copper(II) phthalocyanine-tetrasulfonic acid tetrasodium salt (CuPcTS) combined via supramolecular π-π stacking with graphene and PANI NF showed quite satisfying sensing performance in terms of stability, response and classification.

KEY WORDS: PHTHALOCYANINE/ PORPHYRIN/ GRAPHENE/ PANI/ SOL-GEL/ GAS SENSOR ARRAYS/ INKJET PRINTING

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