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Electrospinning and related techniques: From design to production of advanced polymer materials and devices

12-16 May 2019, Como, Social Como Theatre

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PORPHYRIN, GRAPHENE AND POLYMERS: SMART COMBINATIONS FOR SELECTIVE NANOFIBROUS CHEMOSENSORS FOR GAS AND VOCS

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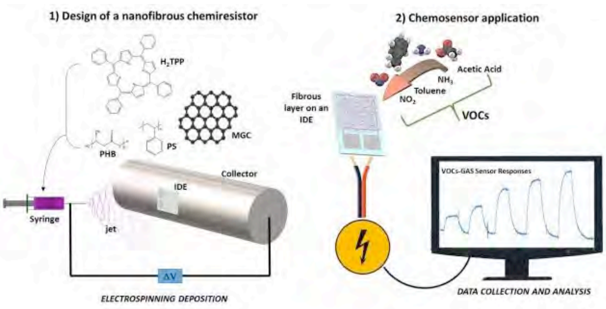
Abstract

Polymer-carbon nanomaterials composites properties sound so attractive in various areas to have become a great challenge, too, in chemical sensors investigation. Here, a thin nanofibrous layer, composed of two insulating and eco-friendly thermoplastics (polystyrene-PS and polyhydroxibutyrate-PHB), a known percentage of nanofillers of mesoporous graphitized carbon (MGC) and a free-base tetraphenylporphyrin (H_2TPP), has been deposited onto an Interdigitated Micro-Electrode (IDE) by electrospinning technology and in a single step (**Figure**). The effects of the combination of a porphyrin with the composite system graphene-polymers appeared evident when nanofibrous layers, with- and without porphyrin, were compared about their morphology, electrical and sensing parameters. Both the resulting sensors were conductive at room temperature and could work between 40 and 70-80 ◦C without any apparent degradation. Therefore porphyrin-doped fibers appeared smoother and thinner (d: ≈175 nm) than porphyrin-free ones (d: ≈550 nm). The latter, indeed, looked extremely rough on the surface and decorated with brighter islands. However, both of them were more resistive at lower temperature, but became much more conductive when temperature rose to 60-70 °C. Porphyrin had a key role in adsorption and diffusion of chemicals, depending on its combination inside the composite fiber, since the response rates dramatically increased (toluene, acetic acid) with temperature. Conversely, the porphyrin-free sensor resulted highly sensitive and selective to acetic acid at 40◦C but the sensitivity fell down when the sensor operated at 80 ◦C. On the other hand, the same sensor increased its sensitivity only to NO_2 when worked at 80°C, reporting a ~2 ppb limit of detection (LOD), thus confirming that temperature, as well as the free-base porphyrin, were two key players in driving the selectivity of the designed nanocomposite polymeric sensors.



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Acknowledgment
The authors gratefully thank Dr. G. Tranfo of National Institute for Insurance against Accidents at Work for her fundamental support in the BRIC ID.12 2016 Project and Mr. A. Capocecera for his technical support in developing customized software for laboratory measurements.