DESIGNING POLYMER-BASED PIEZORESISTIVE STRAIN SENSORS

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Piezoresistive strain sensors have generated considerable interest due to their extensive applications [1]. Tremendous efforts have been devoted to develop highly sensitive strain sensors through a delicate assembly of conductive fillers or unique dedicated microstructure design [2]. The approaches toward conductive polymer composites (CPCs) lack although manufacturing scalability and extensibility. Efforts are still needed to carefully tailor the properties of CPCs based strain sensors so that they can demonstrate competitive advantages over those special structural designed competitors. Another challenge is to achieve optimum functionality with less filler materials

In this contribution, extrusion processed carbon black (CB)-filled CPCs, including polymer blends comprising of thermoplastic polyurethane (TPU) and olefin block copolymer (OBC), are explored as industrially relevant strain sensors. The influence of filler content, kinetic (compounding sequence) and thermodynamic (post thermal annealing treatment) factors on the conductivity and electro-mechanical sensing performances is investigated. For the more conventional binary CPCs, a general trend is demonstrated, showing a three-regime variation of fractional resistance change, $\Delta R/R_0$ versus strain, namely, initiation (I), reversible (II), and re-coverable damage (III) [3]. By exploiting the ternary blend system and controlling kinetic and thermodynamic factors as well as the amount of CB in each polymer phase, it is possible to design the phase morphology and tune the strain sensing performance. Compared with the binary system, comparable initial conductivity and especially monotonic variation relationship and higher gauge factor (sensitivity) can be realized with a lower filler content.
With the developed sensor type a wide range of applications is possible, including the biomedical field.

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