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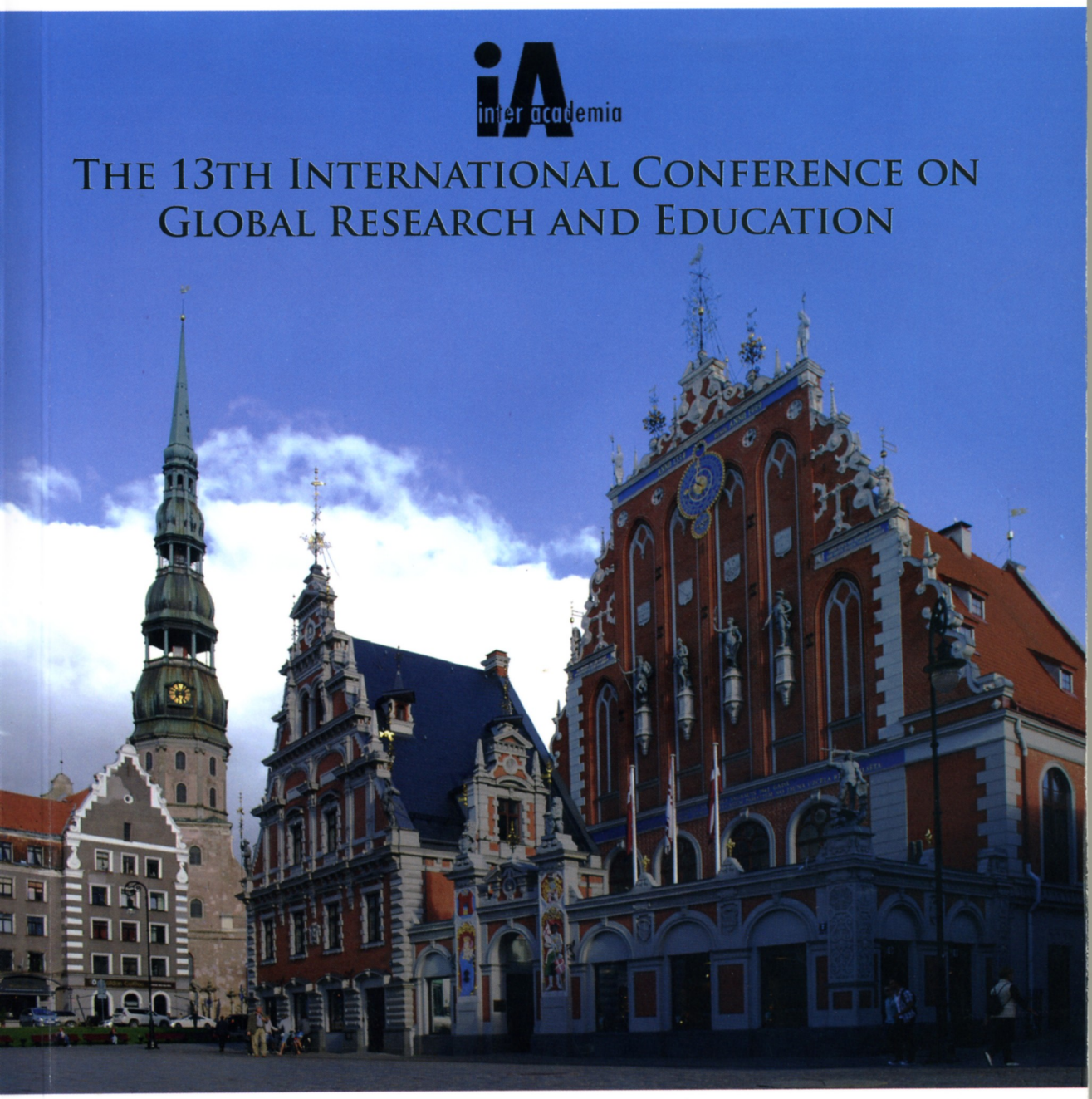

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DIGEST

Piezoresistivity and Electrical Resistance Relaxation of Polyisoprene Nanostructured Carbon Allotrope Hybrid Composites

A. LINARTS and M. KNITE
Institute of Technical Physics, Riga Technical University, Latvia

Summary
Polymer conductive filler composites are believed to be promising materials for flexible force sensor manufacture. Polyisoprene/various carbon allotrope hybrid composites were made and their piezoresistive properties depending on the two types filler concentration and their ratio have been determined. Electrical resistance relaxations of hybrid composites at constant pressure in room temperature were determined as well. Experimental data of resistance relaxation was analysed and fitted similarly to stress relaxation of polymers at constant pressure.

Introduction
Flexible, electrically conductive polymer composites have attracted significant research attention due to possible application as soft stress or strain sensors, soft electronics and even artificial skins. Combined with easy and low cost production, light weight and high sensitivity to external changes piezoresistive polymer nanostructured filler composites are believed to be one of the most promising materials for the previously mentioned application.

Hybrid conductive filler polymer composites are one of the next generation trends in the field of piezoresistive conductive filler polymer composites offering higher sensitivity to external influences compared to conventional polymer conductive filler composites. Moreover, the piezoresistive sensitivity as well as conductivity can be easily tuned by adjusting different filler concentrations and ratios in the composite volume. However, the synergy mechanism between different fillers leading to higher piezoresistive sensitivity in hybrid composites has not been understood completely. Compressive resistance relaxation or changes in resistance of conductive polymer composite during compressive stress relaxation could be one of the methods to understand the synergy more in depth.

Materials and methods
Polyisoprene/nanostructured carbon allotrope hybrid composites were made using solution mixing method. Two carbon filler allotropes were used - carbon black (CB - mean particle size is 30 nm, surface area: 950 m^2/g) and multi wall carbon nanotubes (CNT - outer diameter 50-80 nm, length 0.5-2 μm). The piezoresistive behavior under 1 atmosphere of external pressure were determined using Zwick/Roell Z2.5 universal material testing machine coupled with Agilent 34970A data acquisition/switch unit. Similarly, resistance relaxation was determined under 1 atmosphere of pressure.

Results and discussion

Polyisoprene and carbon nanotube/carbon black hybrid composite piezoresistive sensitivity under 1 atmosphere of pressure depending on both filler concentrations and ratios are shown in Fig. 1.

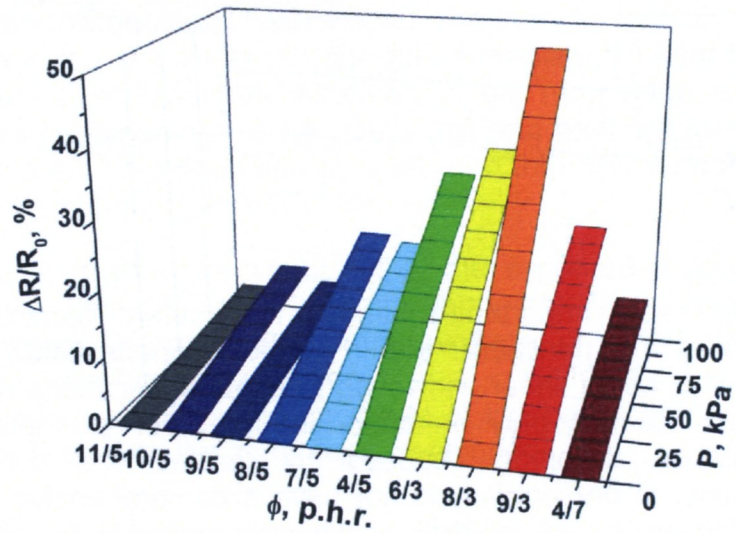

Fig. 1. Piezoresistive sensitivity of hybrid composites at 1 atmosphere of pressure depending on carbon nanotube/carbon black filler concentration and ratio

Conductive channels in hybrid composites are formed from CNT and CB where CB binds the unconnected CNT together to form a conductive grid. During mechanical deformation, CB zero dimentional nanoparticles exhibit better mobility in the composite structure compared to one dimentional CNT leading to a more complete conductive grid breakdown compared to single filler conductive composites.

Conclusion

Maximal piezoresistive sensitivity of polyisoprene nanostructured carbon allotrope hybrid composites strongly depends on the synergy between carbon allotrope fillers.

Acknowledgements

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