AC CONDUCTIVITY OF ELASTOMERIC PDMS-BASED COMPOSITES REINFORCED WITH PANI-COATED AÇAÍ FIBERS

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This work investigates the complex alternating current conductivity, s*(?) = s'(?) + is''(?) (? = 2pf), of elastomeric composites composed of polyaniline (PANI)-coated açaí natural fibers (ANF) dispersed in a polydimethylsiloxane (PDMS) matrix. Electrical measurements were performed under applied pressures ranging from 0 to 200 kPa and frequencies between 1 and 105 Hz to elucidate the combined influence of mechanical deformation and electric field on charge transport mechanisms in disordered polymeric media. The incorporation of conductive fibers promotes the formation of a dispersed conductive phase within the elastomeric matrix, whose electrical connectivity strongly depends on filler concentration and applied compression. The emergence of an electrical percolation regime was observed above 50 kPa and for ANF–PANI/PDMS contents = 7%, indicating the formation of continuous conductive pathways responsible for the significant increase in conductivity. Within the percolative regime, the real part of the conductivity exhibits quasi-universal behavior described by s'(f) µ f?, with s ˜ 0.8, characteristic of structurally disordered solids and consistent with hopping conduction between localized electronic states. The experimental results were interpreted using the Effective Medium Approximation (EMA), percolation theory, and the Random Free Energy Barrier

(RFEB) model, which explains the synergistic role of pressure and frequency in confining charge carriers along the PANI-coated fibers. Increasing pressure enhances interfacial contact between conductive domains, lowers effective energy barriers, and improves electrical connectivity. These findings contribute to a deeper understanding of charge transport in flexible and sustainable polymer composites, demonstrating their potential for fully polymeric strain-sensing applications, flexible electronic skins, stretchable conductive coatings, wearable health-monitoring patches, deformable energy-harvesting interfaces, flexible capacitive devices, and lightweight polymer-based smart substrates for structural and environmental monitoring.

Acknowledgments: The authors acknowledge the Instituto Nacional de Eletrônica Orgânica (INEO) for institutional support and the funding agencies FAPESP (grant no. 2025/27044-5), FAPEMIG, and CNPq (grant no. 408449/2024-1) for financial support.

Palavras-chave: conductive composites; electrical percolation; polyaniline (pani); strain sensors.