Effect of Halloysite Nanoclay on Dielectric and Mechanical Properties of Nanocomposite

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Abstract. This study investigates the influence of halloysite nanoclay (HNT) loading on the dielectric and mechanical properties of polyurethane-based nanocomposites developed using Vukol N22u Magna blue as the matrix. Nanocomposites containing 2 wt.%, 5 wt.%, and 10 wt.% HNT were prepared and evaluated through broadband dielectric spectroscopy and tensile testing. Dielectric measurements revealed two relaxation processes—Intermediate Dipolar Effect (IDE) and α-relaxation—both influenced by temperature and filler content. The 5 wt.% HNT composite exhibited enhanced relative permittivity and reduced dielectric loss, indicating optimal interfacial polarization at this concentration. Mechanical testing showed that 2 wt.% HNT yielded the best balance of tensile strength, hardness, and elongation, while higher loadings led to moderate mechanical gains. These findings suggest the presence of a critical filler concentration beyond which performance benefits diminish. The results confirm that HNT can be effectively used to tailor the multifunctional performance of polymer nanocomposites, contributing to the development of next-generation insulating materials.