The role of the Advanced Characterization in the Polymer Composite Development

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Society faces various challenges in sectors like energy, transportation, and biomedicine, where the generation of new materials is crucial. Many of these applications require multifunctional materials, typically achieved through composites in which at least one component is dispersed in another acting as a matrix. Polymers are commonly used for these matrices due to their wide range of properties and established processing technologies. The multifunctionality of these polymer composites depends on factors such as the chemical nature of the components, compatibility treatments, and final processing conditions. Designing and fabricating new composites necessitates in-depth knowledge of these parameters, utilizing advanced characterization techniques. For instance, combining 2D SAXS/WAXS and X-ray computed tomography enables comprehensive morphological characterization, assessing pore size, crystallinity, and polymer chains' orientation in additive manufacturing samples. This significantly influences mechanical properties, as observed in polyamide (PA12)[1] or derivates of polyetheretherketone (PEEK),[2] both materials processed by additive manufacturing. The orientation of ceramic nanorods in PLA composites can also be evaluated and linked to final properties.[3] In summary, optimizing new composites requires a combination of characterization techniques.

References

1. Cobian, L.; Rueda-Ruiz, M.; Fernandez-Blazquez, J.P.; Martinez, V.; Galvez, F.; Karayagiz, F.; Lück, T.; Segurado, J.; Monclus, M.A. Micromechanical Characterization of the Material Response in a PA12-SLS Fabricated Lattice Structure and Its Correlation with Bulk Behavior. *Polymer Testing* **2022**, *110*, 107556, doi:10.1016/j.polymertesting.2022.107556.
2. Doyle, L.; Pérez-Ferrero, X.; García-Molleja, J.; Losada, R.; Romero-Rodríguez, P.; Fernández-Blázquez, J.P. Fused Filament Fabrication of Slow-Crystallizing Polyaryletherketones: Crystallinity and Mechanical Properties Linked to Processing and Post-Treatment Parameters. *Polymers* **2024**, *16*, 3354, doi:10.3390/polym16233354.
3. Fernández-Gil, F.; Olate-Moya, F.; Aguilar-Cosme, J.R.; García-Molleja, J.; Fernández-Blázquez, J.P.; Cartmell, S.; Palza, H. Micro-Arranged ZnO Particles and Conductive Fillers in PCL Composites for Enhanced Piezoelectric and Dielectric Properties in Bone Tissue Engineering Applications. *Materials & Design* **2025**, *251*, 113672, doi:10.1016/j.matdes.2025.113672.