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Additive Manufacturing with Ceramic Filler

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Abstract : Innovative solutions with additive manufacturing applying material extrusion for functional parts necessitate innovative filaments with persistent quality. Uniform homogeneity and a consistent dispersion of particles embedded in filaments generally require multiple cycles of extrusion or well-prepared primal matter by injection molding, kneader machines, or mixing equipment. These technologies commit to dedicated equipment that is rarely at the disposal in production laboratories unfamiliar with research in polymer materials. This stands in contrast to laboratories that investigate complex material topics and technology science to leverage the potential of 3-D printing. Consequently, scientific studies in labs are often constrained to compositions and concentrations of fillersofferedfrom the market. Therefore, we introduce a prototypal laboratory methodology scalable to tailoredprimal matter for extruding ceramic composite filaments with fused filament fabrication (FFF) technology. - A desktop single-screw extruder serves as a core device for the experiments. Custom-made filaments encapsulate the ceramic fillers and serve with polylactide (PLA), which is a thermoplastic polyester, as primal matter and is processed in the melting area of the extruder, preserving the defined concentration of the fillers. Validated results demonstrate that this approach enables continuously produced and uniform composite filaments with consistent homogeneity. Itis 3-D printable with controllable dimensions, which is a prerequisite for any scalable application. Additionally, digital microscopy confirms the steady dispersion of the ceramic particles in the composite filament. - This permits a 2D reconstruction of the planar distribution of the embedded ceramic particles in the PLA matrices. The innovation of the introduced method lies in the smart simplicity of preparing the composite primal matter. It circumvents the inconvenience of numerous extrusion operations and expensive laboratory equipment. Nevertheless, it deliversconsistent filaments of controlled, predictable, and reproducible filler concentration, which is the prerequisite for any industrial application. The introduced prototypal laboratory methodology seems capable for other polymer matrices and suitable to further utilitarian particle types beyond and above ceramic fillers. This inaugurates a roadmap for supplementary laboratory development of peculiar composite filaments, providing value for industries and societies. This low-threshold entry of sophisticated preparation of composite filaments - enabling businesses to create their own dedicated filaments - will support the mutual efforts for establishing 3D printing to new functional devices.

Keywords : additive manufacturing, ceramic composites, complex filament, industrial application
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