Exploring Ceramic Nanoparticles for Conductive ABS Filaments in Additive Manufacturing

The field of engineering constantly grapples with the dual challenges of cost-efficiency and budget constraints. Our research specifically addresses these issues by focusing on the development of high-K dielectric filaments for 3D printing. Presently, only two overseas manufacturers supply these filaments, each costing $700 per 750 grams. To mitigate these expenses, we have devised an in-house production process that involves dissolving ABS pellets in acetone, combining them with ceramic nanoparticles and plasticizers, and subsequently extruding the mixture to form filament.

Our approach includes experimenting with ceramic additives such as Barium Titanate (BaTi) and Strontium Titanate (SrTi), with plans to explore mixtures of both to optimize dielectric properties. Preliminary tests suggest that increasing the ceramic content correlates with higher K values, aligning with theoretical predictions. However, the initial filaments produced have shown lower K values than anticipated, indicating room for improvement in our process.

Additionally, we are currently addressing challenges related to the printing of custom filaments. Ensuring uniform dispersion of the ceramic nanoparticles within the ABS matrix and achieving consistent extrusion quality are critical factors we are refining. Despite these hurdles, our results thus far are promising, with significant potential for applications requiring superior electrical insulation. The high-K filaments developed through our process are expected to enhance the performance of electrical circuits by minimizing interference, thus improving overall efficiency.

In conclusion, our research demonstrates a viable pathway to producing cost-effective, high-performance low-K dielectric filaments in-house. Continued refinement of our techniques and materials is anticipated to further enhance the dielectric properties and manufacturability of these filaments, ultimately contributing to more efficient and economical engineering solutions.