Study the Mechanical Properties of Stereolithography 3D printed Polymer Nanodiamond Composite.

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Motivation

1. The superior mechanical properties of the Nanodiamond(ND), biocompatibility, superior thermal, electrical and optical properties.
2. Various functional groups can be attached to ND in comparison to carbon nanotubes and graphitic nanoparticles.
3. Stereolithography with combination of Nanodiamond for printing is unique research yet to be explored.

Abstract

The goal of this project is to **study the mechanical properties of Nanodiamond(ND) fillers in nanocomposite resin for Stereolithography (SLA) 3D printers**. In pursuit of this goal, three specific research objectives will seek to:
(1) Study the mixing process of ND-OH in SLA printable acrylate resin.
(2) Study the printing parameters for the nanocomposite resin and comparing to pure acrylate resin.
(3) Evaluate how the printed polymer structure could be enhanced in mechanical properties. The future work adheres to using various other ND-organic compounds for mixing with acrylate resin and trying to print them.

Methodology

Phase I :- Polymetric matrix and nanomaterial Investigation

Extensive research is done in the mixing of NDs with the epoxy resin. The resin which is commercially available is an acrylate compound and the it is totally new field to study about the reaction of the functionalized NDs with the acrylate.

Phase II: Composite Formulation

A ND-resin composite mixture was prepared by directly mixing 0.2% composite with the resin. Similarly ND-OH composite mixture was also prepared on similar grounds.

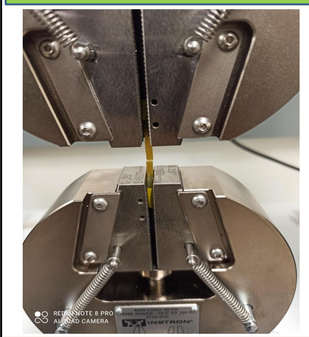
Phase III: Printing Parameters Investigation

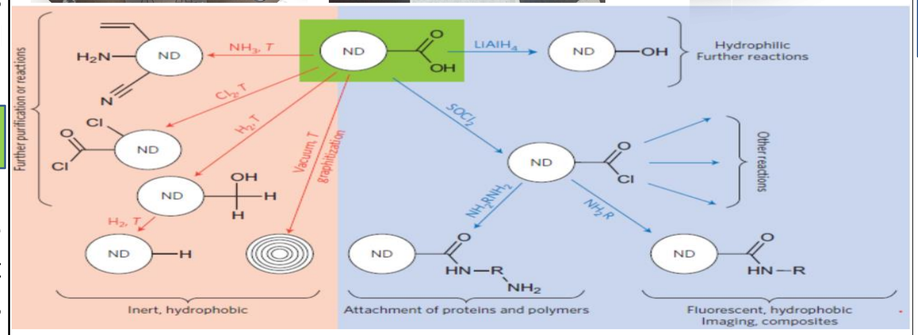
The Kudo 3D stereolithography printer was calibrated with respect to the lift speed, down speed, slicing thickness(0.05 mm),delay time. Along with this the exposure time for the pure resin, ND-resin and NDOH-resin mixture was calculated using the calibration test.

Phase IV: Testing and Evolution

Dog bone samples following the ASTM D638 standards were printed and tested for tensile strength in UTM.

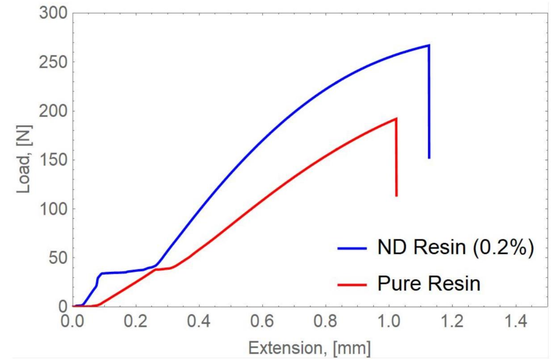
Experimental Setup





Challenges

(1) Finding the correct curing time is an issue.
(2) Kudo printer not performing as expected which delayed printing.
(3) ND-OH is in crystalline form which lead to improper mixing.



Conclusions and Future Work

I could print ND-resin using SLA technique and could conclude that ND-resin structure has a tensile strength of 40% higher than pure resin. Future work consist of printing various structures of varying composition and comparing other mechanical properties.

References

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2. Mangal, U.; Seo, J.-Y.; Yu, J.; Kwon, J.-S.; Choi, S.-H. Incorporating Aminated Nanodiamonds to Improve the Mechanical Properties of 3D-Printed Resin-Based Biomedical Appliances. Nanomaterials 2020.

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