Photocurable Nanocomposites for Cartilage Replacements

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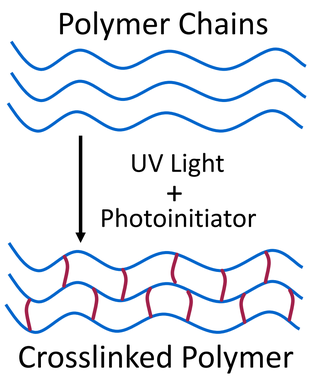
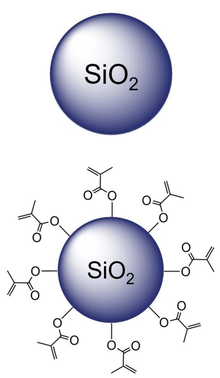
Project Goals

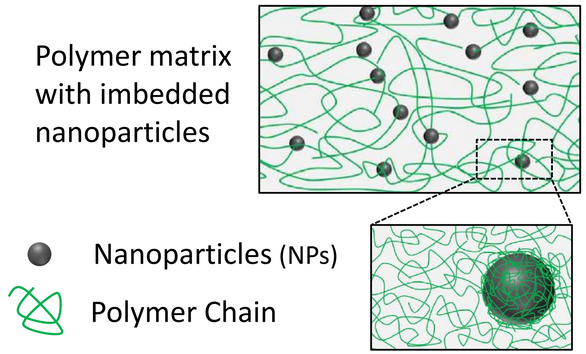
The properties and characteristics of photocurable nanocomposites can be tailored to mimic those of tissues and/or cartilage, allowing the bio-inspired synthetic material to replace them. The goal of this project is to characterize the mechanical properties of this material to better predict its behavior once implemented as a customizable, 3D-printed cartilage replacement.

Background and Methods:

- Previously, nanocomposites with non-functionalized silica (SiO_2) nanoparticles were characterized.
- In this project, a new subset of functionalized nanoparticles (SiO_2-Ma) were characterized 0, 3.8, 7.4, 10.7 and 13.8 wt% NPs.







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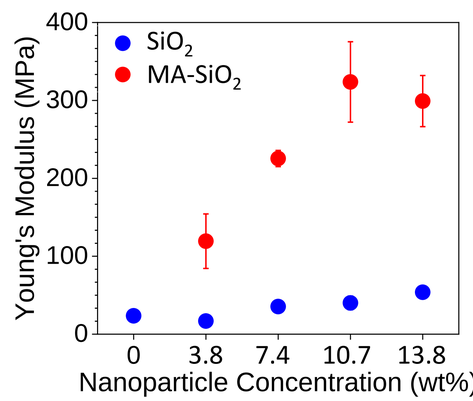
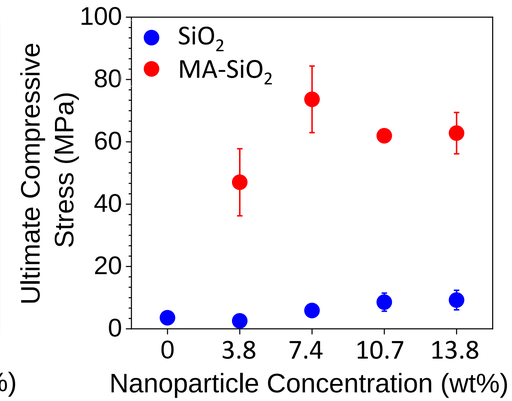
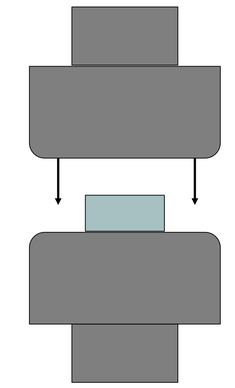
Results

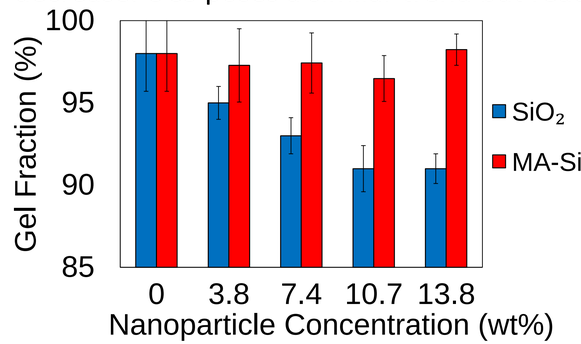




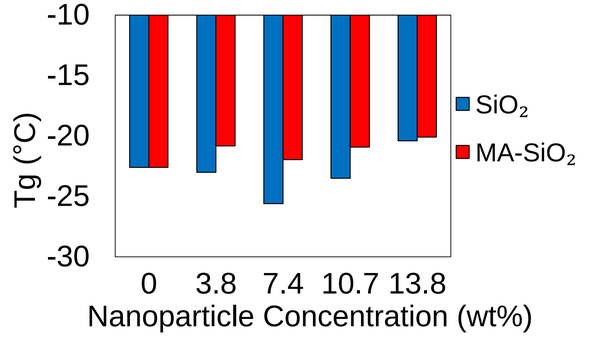


Compressive Testing

Young's modulus generally increases with the addition of SiO_2 NPs. At 10.7 wt% of MA-SiO_2 NPs, the Young's modulus reaches its maximum & begins to decrease. UCS poses a similar trend but reaches its maximum at 7.4 wt%.



The gel fraction tells us how well the crosslinking reaction occurred. An increased presence of MA-SiO_2 did not significantly affect the gel fraction.



The glass transition temperature (T_g) tells us about the flexibility and morphology of the sample. There are no significant changes with MA-SiO_2 NPs.

Conclusion

The findings in this project show that the composite generally incurred more integrity allowing it to withstand greater stress and load, thereby demonstrating the tunability of the composites. This project increased the range and resolution to which properties can be selected for 3D-printed cartilage replacements.

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