Developing Self-Healing Polymeric Nanocomposites through Nanoparticle-based bonds

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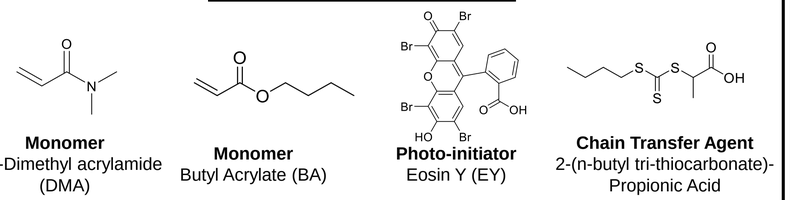
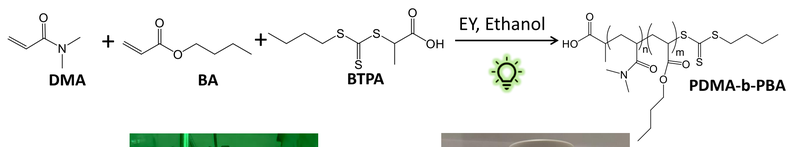
Background

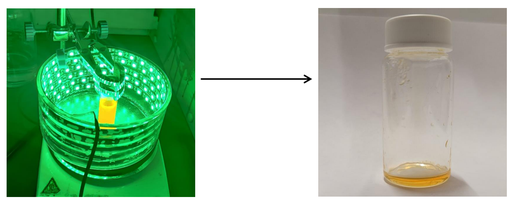
Self-healing materials have captured interest in the field of sustainability due to their remarkable ability to repair damage without human intervention. However, a major hurdle is the trade-off between self-healing and mechanical properties. Traditional Self-healing materials often suffer from low stiffness and glass transition temperature (T_g). This limits their ability to withstand stress and restricts their use in demanding applications. So, a concept of self-healing polymer nanocomposites has been used here, where nanoparticles are incorporated into a polymer matrix with the help of surface functionalised ligands. A copolymer that consists of poly(*N,N*-dimethylacrylamide) (*i.e.*, the hard segment) and poly(butyl acrylate) (*i.e.*, the soft segment) which is then bonded with the gold nanoparticles with the help of surface functionalised ligands (*e.g.*, 11-mercaptoundecanoic acid). The glass transition temperature and stiffness will be significantly improved and can be used for broader range of applications.

Materials/Methods



PDMA-b-PBA Polymerization (PET-RAFT Polymerization)

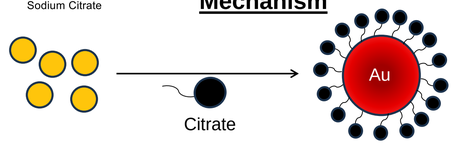




Gold Nanoparticles Synthesis- Turkevich Method

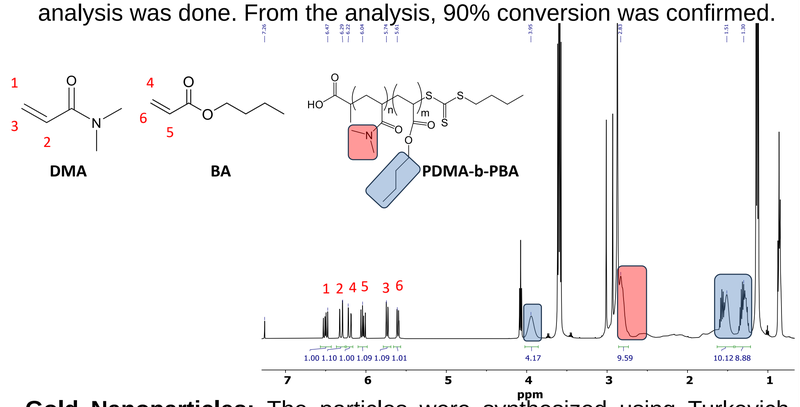
Reaction

Mechanism

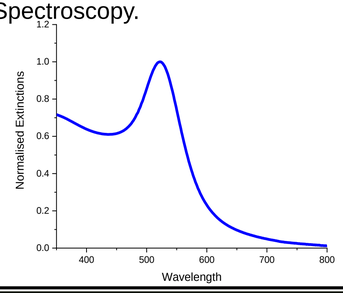


Results / Discussions

- **PDMA-b-PBA**: The reaction was carried out for 16 hours and H-NMR analysis was done. From the analysis, 90% conversion was confirmed.

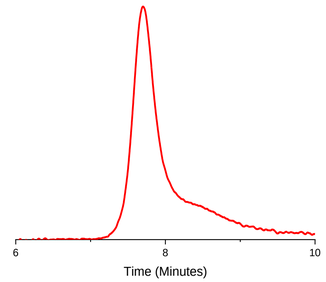


- **Gold Nanoparticles:** The particles were synthesized using Turkevich Method. The analysis below was done with the help of UV-VIS Spectroscopy.



Absorbance (1/cm)	**0.592**
Wavelength (nm)	**522**
Diameter of the Particles Achieved (nm)	**18**

- **Size Exclusion Chromatography** (SEC) was performed for molecular weight analysis. From this analysis, a molecular weight of 55000 was obtained.



Molecular Weight (Da)	**55106**
PDI (Mw/Mn)	**1.097**

Conclusions

- The H-NMR analysis shows 90% conversion of the copolymer.
- The gold nanoparticles formed by Turkevich Method yielded the particles of 18nm diameter, analyzed through UV-Vis Spectroscopy.
- The molecular weight of the Copolymer obtained is around 55000 from SEC analysis.

Future Work

- Producing polymer nanocomposites, by combining my formed copolymers and gold nanoparticles with the help of functionalized ligands.
- After combining the copolymer with nanoparticles, will be doing the test for T_g for copolymer and nanocomposites.
- Self-healing test will be done using DMA and the test for stiffness of the polymeric nanocomposites.

Acknowledgments

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