Investigation of Silicon Nanoparticle-Polystyrene Hybrids

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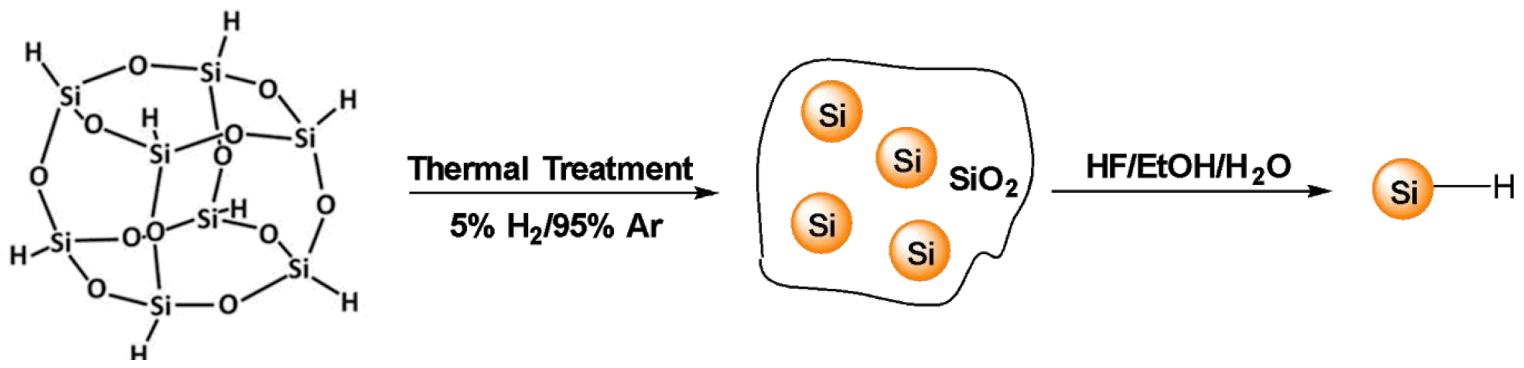
Introduction

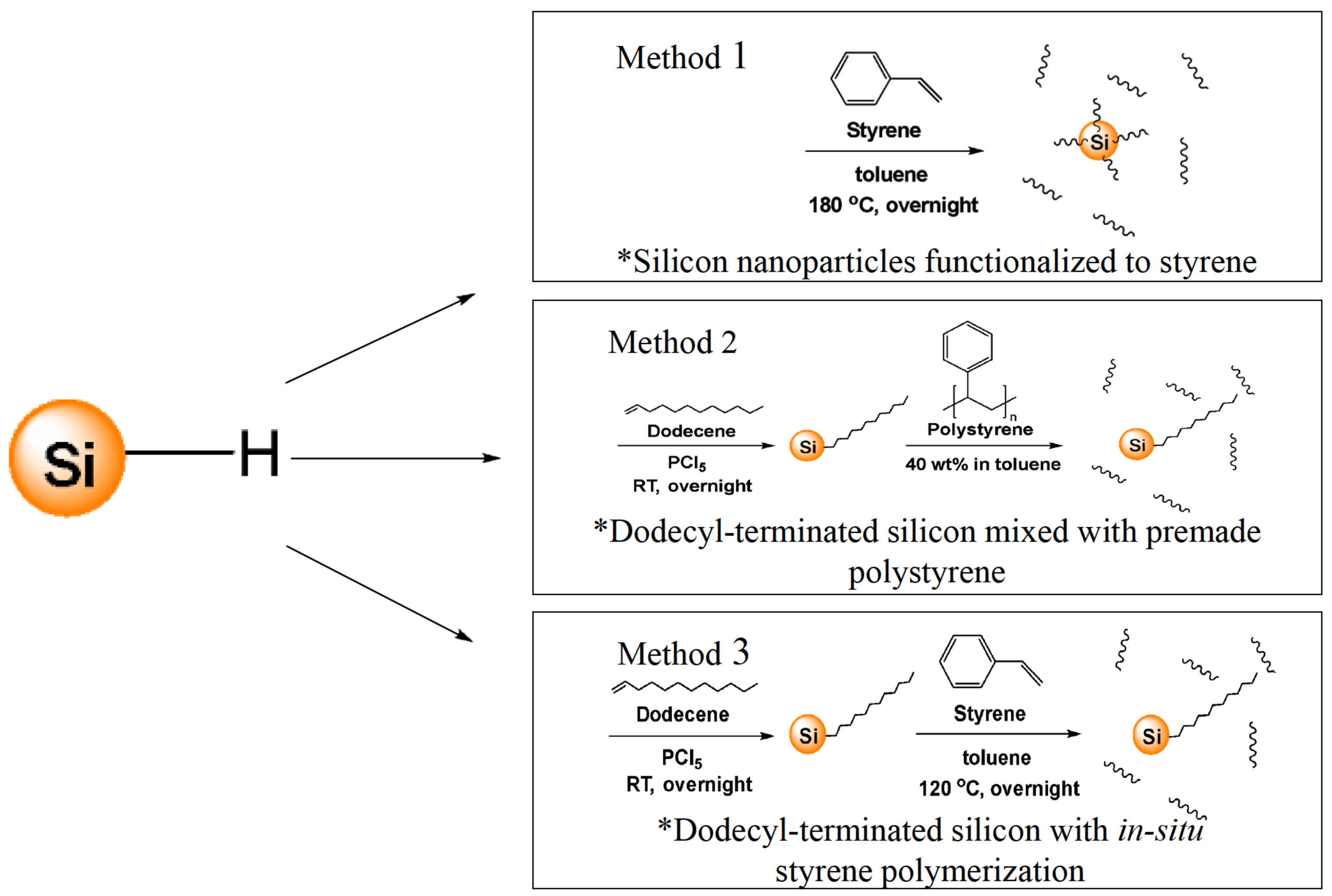
- The problem with current method of creating quantum dot (nanometer sized semiconducting particles) LED lights is that the quantum dots currently used are toxic
- Silicon nanoparticles are better because they are biocompatible and less toxic than other quantum dots
- Silicon nanoparticles offer tunable luminesce and unique chemical properties
- Silicon is also the second most abundant element in the earth's crust
- The object is to use silicon nanoparticle-polymer hybrid to make LED lights and getting the lights onto flexible material

Methods

How to Make Hydride-Terminated Silicon Nanoparticles



Synthesis of Silicon Nanoparticle-Polystyrene Hybrid



Results

Figure 1: Silicon nanoparticle/polystyrene hybrids under visible and UV light

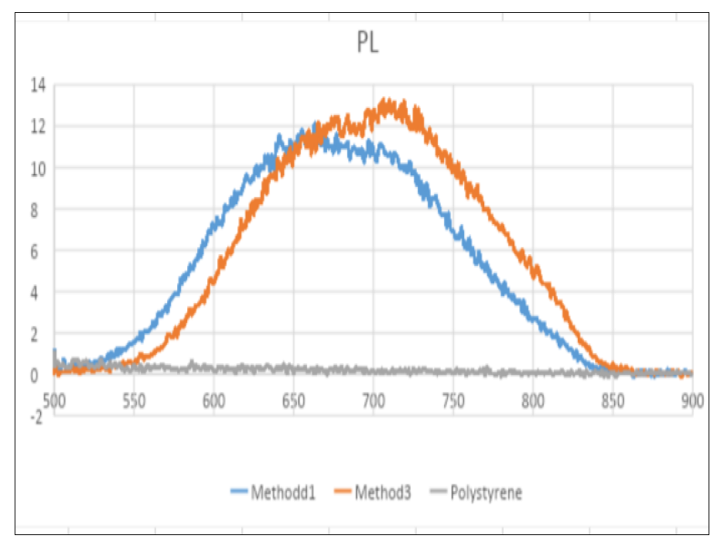


Figure 2: Photoluminescence spectra comparing the silicon nanoparticle-polystyrene hybrids from each of the methods

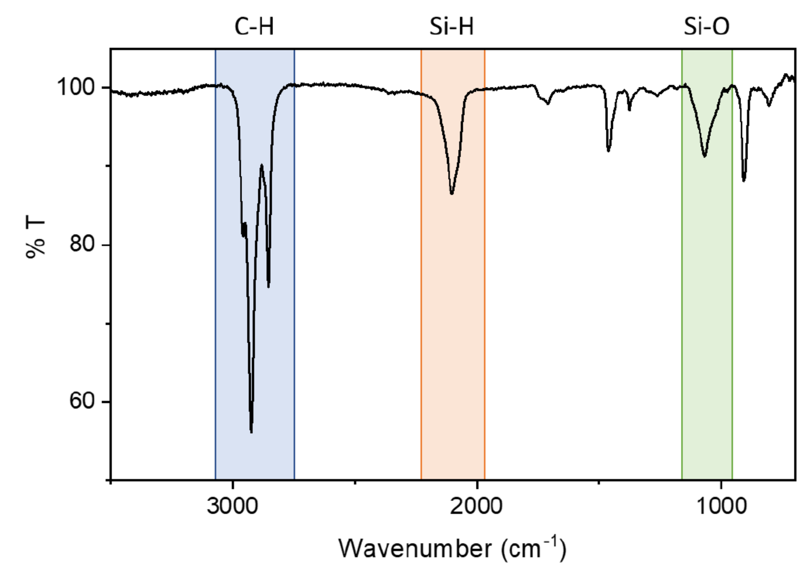
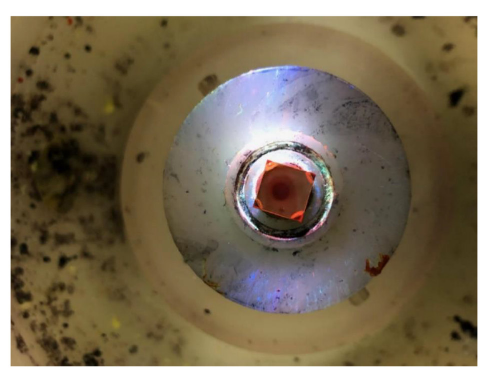


Figure 3: FTIR spectrum showing functionalization of dodecyl-terminated silicon nanoparticles

Spin Coating

0.05g/ml composite in toluene, 30 µL, 30 seconds

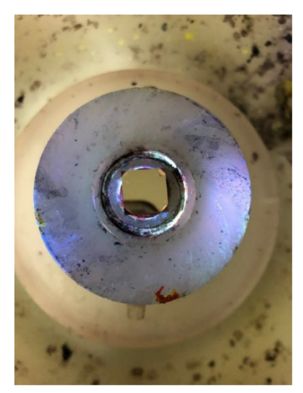
Method 1



1000 rpm

Solution yielded a consistent, bright, and homogeneous film. Method 1 was an ideal sample. High molecular weight therefore the polymer evenly spread over the film

Method 3



1000 rpm

Homogeneous film but not very bright. Assumption is that there is low molecular weight therefore the polymer resulted in a thinner film

500 rpm

The film was not homogeneous. Speed is too slow for solvent to completely evaporate therefore polymer didn't evenly spread

Conclusion

- Method 1 gave a homogeneous mixture that resulted in the best films after spin coating
- Method 2 gave better control of the amount silicon nanoparticles inside the polymer hybrid
  - Did not create a homogeneous mixture most likely due to the different structures of dodecyl-terminated silicon nanoparticles and polystyrene
- Method 3 was a homogeneous mixture
  -The *in-situ* polymerization stabilizes the PCl_5-functionalized particles
  - We use PCl_5 to functionalize the particles because we want to have brighter particles
  - Lowered the temperature for the polymerization step to lower the molecular weight of the polymer for easier operation (i.e. easier to dissolve)
- Different methods resulted in different polymer molecular weight. This created distinct properties between the polymer hybrids when spin-coating

Future Work

- Tune the polymer concentration when spin-coating
- Adjust amount of particles placed in the polymer
- Additional characterization of polymer hybrids

References

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Acknowledgements

I would like to thank the Veinot Research Group, Jonathan G.C. Veinot, Alyxandra Thiessen, I Teng Cheong, Gunwant Matharu, my sponsor NSERC Promo Science, and my teachers at Wainwright Highschool