

1. Student name: Anthony Clarence Chua Goo

2. Faculty mentor name: Professor Ryan K. Roeder

3. Project title: Nanoparticle Contrast Agents for Spectral Computed Tomography

4. Briefly describe any new skills you acquired during your summer research:

- Operation of Micro Computed Tomography Equipment
- Dynamic Light Scattering
- Gold Nanoparticle Synthesis
- Diamond Saw and Wire Saw Operation
- Essential Lab Techniques

5. Briefly share a practical application/end use of your research:

Spectral computed tomography can detect energy-dependent differences in x-ray contrast which enables enhanced differentiation between tissues, and contrast agents. To quantitatively determine the concentration of a given contrast agent in a scanned sample, the image must be calibrated against samples of known contrast agent concentration. Creating nanoparticle contrast agent phantoms allows for the quantification of contrast agents in tissue samples.

Begin two-paragraph project summary here (~ one type-written page) to describe problem and project goal and your activities / results:

X-Ray computed tomography is a commonly used medical diagnostic tool enables non-invasive 3-D anatomic imaging. Spectral CT uses multiple x-ray energy levels to differentiate contrast agents used in CT by looking at the contrast agent's change in attenuation with respect to photon energy level. Quantitative determination of contrast agent concentrations in tissue samples require calibration against samples of known concentrations. Contrast agent phantoms must be readily manufactured and must maintain the same attenuation and concentration properties over and indefinite period of time.

Initially, nanoparticle contrast agents were suspended in solvents such as water or ethanol. While this allowed for the exact initial concentrations to be measured, evaporation of the solvent eventually changed the volume and NP concentration. Furthermore, the low viscosity of the solvents led to nanoparticle sedimentation. Encapsulation of the NP in a polymer reduced these issues. However the volumetric shrinkage of the initial polymer caused a build-up of internal stresses leading to internal crack formation, making them unfit for CT use. A literature search and a change in polymer constituents provided a new polymer with superior volumetric shrinkage results.

Following polymer identification, nanoparticle contrast agents were mixed into the polymer and poured into preformed phantom molds. The polymerization inside premade molds caused airpocket formation and separation from mold walls. To avoid these issues, polymerization of the NP tubes were conducted in separate tubes. These NP were then extracted from their individual containers and placed in stands, and excess polymer was then poured around the tubes and polymerized. Polymerizing around the NP tubes prevented the formation gaps between the samples and the surrounding polymer. The whole sample was then machined into an appropriate size, resulting in a nanoparticle phantom containing several tubes of known concentrations that was imaged by microCT.

Publications (papers/posters/presentations):

NDnano Undergraduate Research Fellowship Powerpoint Presentation (July 22nd 2015)