1. PRF# 55468-UR7

2. Petroleum-Based Epoxy Mirrors with Optically Smooth Surfaces

3. Dr. K. Lisa Brodhacker, Lander University

Two students have worked on the project for this past period. They both have graduated with one now attending graduate school (Chemical Engineering) at Penn State and the other being employed at a local chemical company. In addition, all previous students funded through this grant are working in industry or attending graduate school. The impact you have had on their lives is immense. A couple of them are first generation college students. Their strong resumes come from being a part of a competitive research group; and they are much better prepared to meet the challenges outside of our university.

This grant has also greatly affected my career. The granting period of three years overlapped my promotion of full professor. Because of the funding, the opportunity to hire students and being free to work in the lab I exceeded almost all expectations for promotion. Dr. Slimmer, Dean of the College of Science and Math made this comment in my promotion packet, "Lisa's annual reviews are an impressive display of the contributions she has made, and the comments from both her colleagues and her students indicate that she contributes an essential part to the programs in our college and to the university in general."

Three areas of research were our focus during this period: gathering DMA and TMA data from previous samples; testing the specific heat, thermal conductivity and viscosity of various formulations; and making and testing flat mirrors for magnetic responses.

Student researchers were fully trained on the Dynamic Mechanical Analyzer (DMA) and the Thermal Mechanical Analyzer (TMA). About 60 samples with various epoxy formulations containing diglycidyl ether of bisphenol A (DGEBA) and cyclohexane dimethanol diglycidyl ether (ED757) were tested; as well as samples containing functionalized polyhedral oligomeric silsesquioxanes, functionalized multi-walled carbon nanotubes and functionalized silicon dioxide. Students gathered data for glass transition temperatures, Coefficient of Thermal Expansion (CTE) data, and modulus data.

Because we are spinning the epoxy, we had to understand what the additives did to the viscosity of the epoxy. Another student tested the viscosity of formulations containing both the carbon nanotubes and silicon dioxide and compared that to our regular formulation with no additives. Samples containing up to 5% CNT and 5% SiO_2 had viscosities very close to our neat epoxy; those with higher percentages cannot be used in spinning a mirror.

We also have much data concerning the specific heat and thermal conductivity of various samples. These are important parameters for telescope mirrors. One student was very good at building things so he took it on himself to build an apparatus to measure thermal conductivity since funds did not allow for elaborate instrumentation. Figure 1 shows a schematic this apparatus and figure 2 shows his actual apparatus.

Lastly, samples containing magnetic nanoparticles were prepared and sent to Gravic Labs in Pennsylvania who tested them for us. Figure 3 shows the set up for testing the magnetic response of the mirrors and explains the magnetic sources we have used. We have produced flat mirrors with magnetic particles more than sufficient to deflect the mirrors by multiple waves. We have now progressed to spun mirrors with the magnetic particles and anticipate good results with these.

Let me reiterate how grateful we are to the donors of the American Chemical Society Petroleum Research Fund for support of this research. This grant has benefited several students and has advanced the research to the next level. Thank you for your support.

H: Steam Chamber

M: Top Brass Disk

S: Sample

B: Bottom Brass Disk

T_1: Thermometer (top disk)

T_2Thermometer (bottom disk)

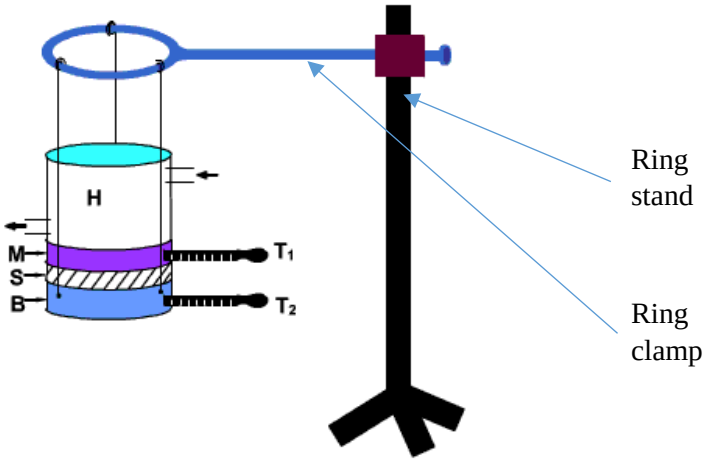

Figure 1: *Schematic of the thermal conductivity apparatus*

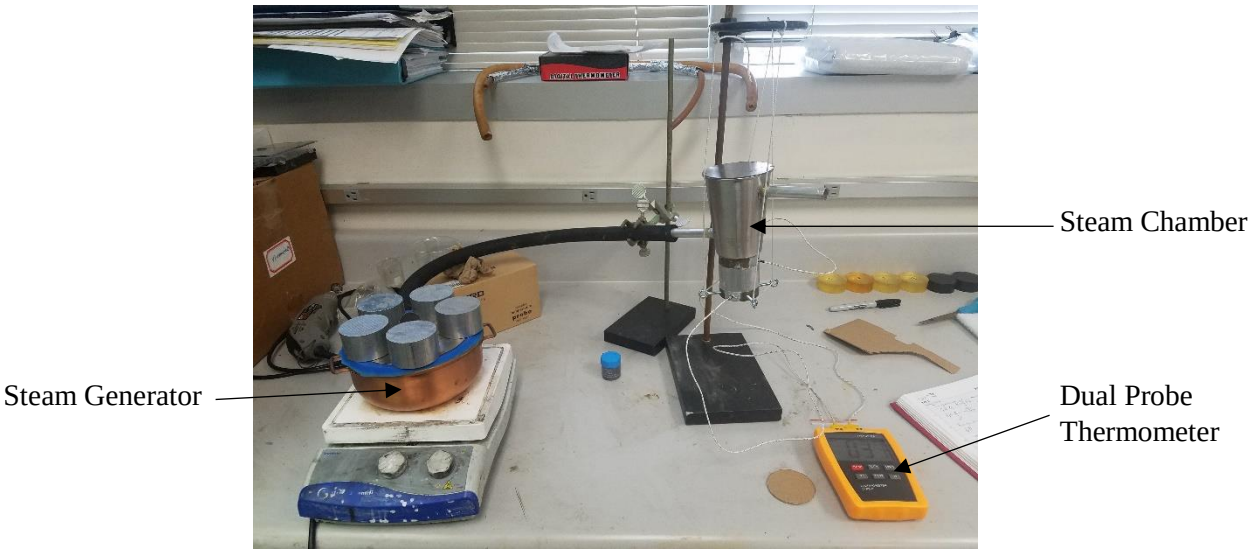

Figure 2: *The actual apparatus used in our lab to measure thermal conductivity of epoxy samples.*

Figure 3 (r): A mirror sample is firmly mounted in a test stand by the center hole. (l): Two different magnetic actuators have been tested: A solenoid that at 12v produces 25N force against an iron plate (upper right). And a stack of two N48 Neodymium rate earth magnets 2mmx13mm each (seen in the lower left attached to the metal plate).