UNIVERSITY OF NOTRE DAME NDnano CENTER FOR NANO SCIENCE AND TECHNOLOGY

1. Student name: Arnau Rodríguez Rubio

2. Faculty mentor name: Hirotaka Sakaue

3. Project title: Development of a chemical sensor for fluid dynamic applications.

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

- Working on an interdisciplinary research project.
- Introduction to TSP systems and its applications.
- Crafting an own set-up for measuring luminescent output.

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

A Temperature Sensitive Paint (TSP) can be applied to any object in order to measure temperature differences in its different areas. From a fluid dynamic viewpoint; it can be used as a coating for spacecraft, pointing out where the highest temperatures are reached to optimize its design later on.

<u>Project Summary</u>

Temperature resistant coatings are such an important part of the designing process of an aircraft or spacecraft to resist high levels of friction. In order to optimize the weight and ensure a perfect protection to high temperatures it is important to know the exact zones where this coverage is needed. So a technique that enables us to map the "hot zones" would be very useful. Temperature sensitive paints (TSP) have been used to achieve such purpose. TSPs are polymer-based paints in which the temperature-sensitive luminescent molecules are immobilized. The quantum efficiency or intensity of emission decreases with the increase of temperature, so we can correlate both parameters. However, to ensure a reliable calibration one has to make sure that both the composition and application of the TSP are homogenous prior to the start of calibration. Usually, TSPs have been made of organic chemicals or metallic complexes dissolved in a polymeric matrix, the present job focuses on a novel approach dispersing up-converting nanoparticles in a polymeric matrix.

The incorporation of this different chemical as the source of luminescent output is believed to enable higher temperature measurements. It is worth to remember the importance of the homogeneity when the paint is applied to a surface. Taking this into account, an important characteristic of our novel paint had to be a high enough viscosity so it can keep the nanoparticles

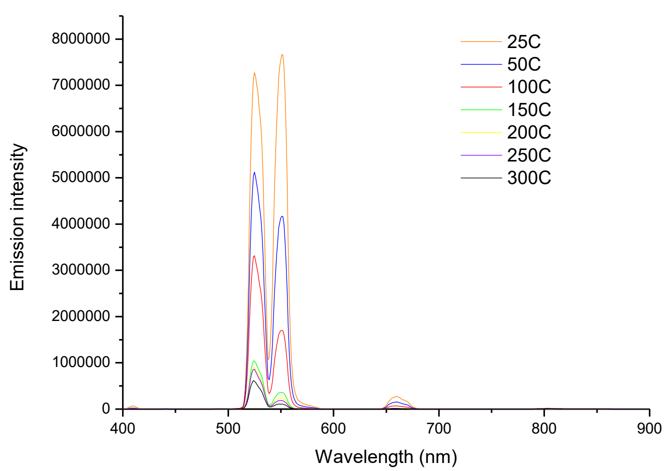

Figure 1. Emission spectra at different temperatures.

suspended enough time (homogenous composition) while it can also be sprayed (homogenous application). Two different polymers were studied to find the one which better fulfilled our needs. Both acted well as a glue and immobilized the nanoparticles to an aluminum surface, none interacted with the luminescent output, but one yielded to a “better” paint in terms of viscosity. Once the matrix was chosen two different chemicals were trialed, but just one of them gave luminescent output under 980 nm laser light. Finally, a small sample of the paint was tested on an aluminum plate from 25ºC to 300ºC and attempted a calibration. As it can be seen in Figure 1, the nanoparticles show two emissions: one at 525 nm and 550 nm, making a ratio between those two intensities we found a correlation with the temperature that is shown in Figure 2. Further studies have to be done before using this as an actual sensor, e.g.: nanoparticle concentration, test other chemicals, higher temperatures, etc. However, we have set a good starting point and yield to further work to be done on this field.

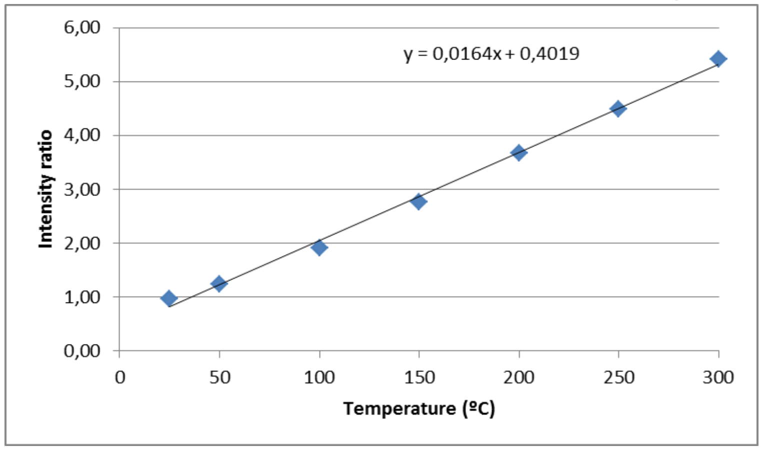

Figure 2. Intensity ratio against temperature.