**INTRODUCTION & MOTIVATION**

Nanoparticles embedded within a matrix have the capability of improving a wide variety of mechanical properties. Alumina-based nanocomposites have the ability to provide intrinsic characteristics of this enhancement through the stress-sensitivity of photo-luminescent emissions.

**OBJECTIVES**

- Study Al₂O₃ particulate mechanics with piezospectroscopy.
- Establish particle-matrix load transfer characteristics under varying parameters including volume fraction and strain rate.

**PIEZOSPECTROSCOPY**

Piezospectroscopy is the method of monitoring the optical spectrum of a photo-luminescent material and correlating spectral peak shifts to stress through the PS coefficient. Once excited with a laser source, alumina emits an optical spectrum consisting of distinct stress-sensitive peaks, R1 and R2, due to its naturally occurring Chromium ion (Cr³⁺) impurity. By monitoring the resulting spectral peak shifts of R1 and R2, particle stress can be determined.

**RESULTS OF PIEZOSPECTROSCOPIC RESPONSE**

**NANOComposite STRain RATE EFFECT**

The experimental set up contains a load frame which places the sample in compression, while PL data is collected by utilizing a laser excitation source. Varying strain rates resulted in varying load transfer from the matrix into the nanoparticles. As the strain rate (10⁻² s⁻¹, 10⁻¹ s⁻¹, and 10⁻⁴ s⁻¹) increases, the ultimate strength of a nanocomposite sample increases [8].

**ISOLATED PARTICLE LOAD TRANSFER RESULTS**

To better understand particulate load transfer, a macro-scale analysis of single particle composites, on the millimeter scale, was conducted. Experimental values lead to an R1 PS coefficient of -4.56 ± 0.21 cm²/GPa. This indicates that the particle is sustaining a stress ratio of 0.60 [7].

**FUTURE WORK**

Future work includes the analysis of X-ray diffraction results from experiments conducted at the Canadian Light Source X-Ray Synchrotron Facility. X-ray diffraction was chosen due to its ability to measure stress through the particle, as opposed to photo-luminescence which is a surface measurement.

These experiments included samples with varying Al₂O₃ particle sizes to analyze particle size effect and compare to volume fraction effect.

A manually-actuated load frame was used to apply force to the epoxy matrix, and a load cell was used to collect force data. As a force is held on the matrix, the x-ray synchrotron beam produces XRD rings which are strain sensitive. The ring contours can be measured and related to strain.