# Demonstration of Thin Film Ruby as a High Spatial Resolution *In-Situ* Pressure Sensor

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Quantification of the non-hydrostatic pressures present during a typical diamond anvil cell experiment, and their impact on materials properties, remains challenging. This work demonstrates novel thin film ruby pressure sensors that can be used to easily measure non-hydrostatic pressures with great spatial resolution.

Ruby thin films were deposited using pulsed-laser deposition (PLD) onto 1 inch diameter (0001) sapphire and (100) yttria-stabilized zironia (YSZ) single crystal substrates. After crystallization, the films were analyzed with X-ray diffraction and shown to be epitaxial on sapphire and (0001) preferentially oriented on YSZ. Fluorescence spectra were taken across the sample surface with a step size of 0.2mm between spectra. Pressure was then calculated from the fluorescence peak positions using the piezospectroscopic tensor of ruby, assuming a biaxial stress state, which showed that ruby on sapphire was under a pressure of 100 $\pm$ 9 MPa and ruby on YSZ was under 1809 $\pm$ 204 MPa. These fluorescence pressure measurements were confirmed by measuring thin film-substrate sample curvature and using Stoney's Equation to calculate film pressure. The pressure calculated from these curvature experiments was 91 $\pm$ 10 MPa for ruby on sapphire and 1866 $\pm$ 23 MPa for ruby on YSZ, both of which agree with the stress determined from the fluorescence measurements. These results highlight the accuracy with which these ruby thin film pressure sensors can measure non-hydrostatic pressures.