MATERIALS ENGINEERING SEMINAR

"Properties of Infrared Transparent Optical Ceramics via DFT"

By
George (Joji) Nishibuchi

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Advisor: Professor Alejandro Strachan

ABSTRACT

Ceramics with novel optical properties have enabled substantial advances in technologies ranging from medical imaging to fish finding. Hypersonic aerospace applications often utilize infrared (IR) imaging for guiding and target identification. Sensors utilized in the detection and measurement of IR radiation cannot withstand the extreme environments intrinsic to hypersonic travel, and thus must be protected from the surrounding environment while minimizing distortion of incident IR radiation. Towards this end, IR transparent ceramics have been developed that can withstand the extreme environments of hypersonic travel, while maintaining their optical and mechanical properties. The binary II-VI semiconductor Zinc Sulfide (ZnS) has been primarily utilized for this application due to its strong transmission of 8-10 μm IR radiation in combination with the stability of its mechanical properties at the elevated temperatures experienced at high airspeeds. While it has proven to be a capable material for the application, previous testing has found it to degrade and fail catastrophically when exposed to sand or water at subsonic speeds. This created a search for materials with similar IR transmittance properties to ZnS but with higher strength and resistance to degradation. The ternary sulfide Calcium Lanthanum Sulfide (CLS, $CaLa_2S_4$) was discovered in the early 1980s, with an extended IR transmission window of 8-12 μm in contrast to the 8-10 μm transmission window of ZnS. In combination with more favorable mechanical properties than ZnS, $CaLa_2S_4$ has become a promising candidate towards the manufacture of stronger IR windows for aerospace applications. To expand the existing body of knowledge on this ternary sulfide and towards the advancement of IR window materials, this work seeks to utilize density functional theory to characterize defects and optical properties of CLS to guide future investigations of this material system.

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Place: DLRC 131 or via https://purdue.webex.com/join/strachan

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