



# Leveraging Light to Enable Tomorrow's Electronics

**Thomas Beechem**

*Associate Professor of Mechanical Engineering*

**TUESDAY November 12<sup>th</sup> @ 2:00 pm in BRK 1001**

*Coffee and snacks served before seminar*

**Teams link in Outlook event**

## **Abstract:**

The microelectronics game remains much the same as it has for decades. Do more, faster, and in a smaller footprint. Big data, artificial intelligence (AI), and cloud computing each rely on the continual improvement in hardware to make this so. Difficulties in both the fundamental physics and the long-standing architectures of computing necessitate innovation more revolutionary than evolutionary to realize these future hardware gains. New approaches must be considered. With this motivation, we examine here the differentiating potential of using light towards these ends. First, hybrid infrared photons and phonons—called phonon-polaritons—are shown to enable new heat dissipation pathways superseding traditional heat carriers at the ultrasmall (<50 nm) length scales of gate all around transistors. Second, we demonstrate the utility of spectroscopic methods to assess the phase stability, fatigue, and imprint belying the device characteristics of ferroelectric hafnium zirconium oxide ( $\text{Hf}_x\text{Zr}_{1-x}\text{O}_2$ , HZO) devices being pursued as a means of relieving the von Neumann bottleneck. Taken together, the work underscores the potential of leveraging nanophotonic concepts to enable gains in the operation and characterization of next generation microelectronic architectures.

## **Bio:**

Thomas Beechem is an Associate Professor in the School of Mechanical Engineering at Purdue University. Before joining Purdue in August of 2021, Thomas was a scientist at Sandia National Laboratories in Albuquerque, NM, for 12 years where he held an affiliate appointment with the Center for Integrated Nanotechnologies (CINT). During his time at Sandia, he was part of teams receiving two *R&D 100 Awards*, received a 2015 Defense Program Award of Excellence and was named one of Sandia's "Up and Coming Innovators" in 2016. He has authored more than 100 archival publications, holds 7 patents, and had his work selected as the featured "cover article" on 5 separate occasions by 6 different periodicals. A fellow of ASME, Thomas served as an associate editor for its *Journal of Heat Transfer* for six years. At Purdue, he was awarded the Robert W. Fox Outstanding Instructor Award in 2023 from Purdue's School of Mechanical Engineering and Purdue's College of Engineering Faculty Excellence Award in Early Career Research in 2024.