



Purdue Quantum Science and Engineering Seminar



Peter Bermel
*Associate Professor
and Associate Director
of Graduate
Admissions in
Electrical & Computer
Engineering,
Purdue University*

Dr. Peter Bermel leads the Energy & Nanophotonics research group at Purdue University that leverages nanophotonics to improve the performance of photovoltaics, thermophotovoltaics, quantum optics, and secure electronics. He serves as the PI for two multi-million dollar centers in secure electronics: ASSURE and Cornerstone. He has received a total of 27 awards from major research sponsors, such as the National Science Foundation, the Office of Naval Research, the Department of Energy, the Semiconductor Research Corporation, Northrop Grumman Corporation, NEC Corporation, the Purdue Research Foundation, Indiana Innovation Institute, and the US Army. He is a recipient of a National Science Foundation (NSF) CAREER award, a Winston Churchill Foundation Scholarship, an NSF Graduate Research Fellowship, and an MIT Compton Fellowship. Dr. Bermel is widely published in scientific peer-reviewed journals, and has been cited over 6,500 times, for an h-index of 31. His work is a recurring topic in publications geared towards the general public, including the *Economist* and Medium.

“Color Centers for Room-Temperature Quantum Optical Communications”

**Monday, February 3, 2020
3:30 – 4:30 p.m. BRK 2001**

One of the foundational requirements for quantum optical communications is indistinguishable state preparation. While many methods have been proposed, one of the leading candidate for room temperature operation is spontaneous parametric down conversion. However, these sources are typically limited in bit-rate and probability of success. At room temperature, observation of photon indistinguishability requires temporal coherence. Pure dephasing in otherwise identical photons decreases indistinguishability by a factor of $2T_1/T_2$. To compensate for phonon-induced dephasing at room temperature, the emission lifetime needs to be shortened considerably, so that photon indistinguishability can be restored. One can view this approach either as achieving photon emission before decoherence occurs, or as reducing the time jitter of indistinguishable photons.

In this presentation, I will describe our group's efforts to greatly increase the generation rate of indistinguishable single photons via tremendous enhancement of the optical local density of states. Deterministic single photons from diamond impurity-based color centers are a promising baseline approach, which theory shows can be significantly enhanced via incorporating of a multilayer nanoshell structure. A particular advantage of the latter, demonstrated via modeling, is greatly reduced sensitivity to loss and orientation. We find that the enhancement across a broad range of positions and orientations associated with a Xenon-related color center in a nanodiamond is over 1200 times the baseline value without this structure. Driven by this finding, we also present preliminary our methods and preliminary results in preparing xenon color centers with core-shell coatings for emission enhancement. Finally, we validate our model against our experimental data, and discuss possible future work in this area.