

THE DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING SPEAKER SERIES

PRESENTS

Nanoantenna-induced carriers and nonlinear susceptibility in 2D materials

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LECTURE ABSTRACT

Two-dimensional (2D) nanocrystals (NC) offer a direct bandgap spanning the solar spectrum as well as enhanced electron mobility and gate tunability. Decoration of 2DNC by nanoantennae (NAE) has enhanced measured photocurrent. But challenges in simulating, characterizing and fabricating 2DNC-NAE hybrid structures has constrained their implementation in functional photovoltaic devices. My lab has examined nonlinear susceptibility, $\chi^{(2)}$, in transition metal dichalcogenide (TMD) and NAE-modulated carrier injection in 2DNC, i.e., graphene and TMD. Monolayer 2DNC that was chemical vapor deposited or liquid exfoliated from bulk was evaluated. 2DNC were decorated by gold (Au) and silver (Ag) NAE through three methods (i) evaporation, (ii) drop-casting and (iii) direct reduction. Electron energy loss spectroscopy (EELS) was used to predict and induce plasmon bright, dark, and hybrid modes. EELS enabled quantitative femtosecond-scale measurement of spectroscopic plasmon dephasing and nanometer-resolved mapping of electric fields on the 2DNC-NAE hybrid. Coupled and discrete dipole simulations were used to characterize radiative and intraband dephasing in order to distinguish contributions to photocurrent from field enhanced electron hole pair generation and carrier injection. Hyper Rayleigh Scattering was used to measure $\chi^{(2)}$ in comparison with indirect classical calculations. These results show new ways to integrate enhanced 2DNC into devices.

SPEAKER BIOSKETCH

D. Keith Roper is Associate Director of Microelectronics-Photonics Graduate Program, Professor of Chemical Engineering, and holds the Charles W. Oxford Professorship of Emerging Technologies at the University of Arkansas. He is Associate Editor for IEEE Transactions on Nanotechnology and Member of the National Academies of Science, Engineering, and Mathematics Committee for Continuous Manufacturing for Modernization of Pharmaceutical Production. He served as NSF Program Director and Program Leader for the Engineering Research Centers and the Network for Computational Nanotechnology from 2012-2016. He partners with leaders in academia, industry, and government to translate discovery to marketable innovations in biotech/ biopharma, chemicals, optoelectronics, and energy. He is a Fellow of the American Institute for Medical and Biological Engineering and a member of the Arkansas Academy of Science. His research examining bioinspired electrodynamic functionality of nano-, bio-, and meta-materials has received recognition from DOE, EPA, and NSF and has been featured by *SPIE Newsroom*, *R&D Mag*, and over 40 other media outlets. From 1994-2000 he developed processes for cell culture, fermentation, recovery, and analysis of protein, nucleic acid, bacterial polysaccharide, and adenoviral-vectored antigens at Merck & Co. From 1996-2008, he was instrumental in bringing three transgenes, 24 vaccine antigens and one anti-cancer compound, to human clinical trials and/or to market. He has developed novel bioprocess equipment for mixing and filtration. He has authored or coauthored more than 80 technical articles and published proceedings, 77 invited lectures, 136 conference presentations, two textbooks, 6 federal solicitations and dear colleague letters, two book chapters, three U.S. patents, one E.P. patent, and six U.S. patent applications.

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