IBS CINAP Seminar

November 28, 2019, 4:30PM

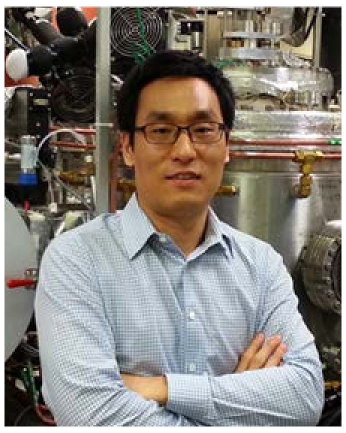
Room 86126 (N Center), Sungkyunkwan University

Carrier-resolved Photo-hall Effect

Byungha Shin

Dept. of Materials Science and Engineering, KAIST

Abstract: Majority and minority carrier properties represent fundamental parameters governing semiconductor device performance. Obtaining this information simultaneously under light illumination would unlock many critical parameters such as recombination lifetime, recombination coefficient, and diffusion length; while of critical importance for optoelectronic devices and solar cells, this goal has remained elusive. Studies to collect both majority/minority carrier properties for high-performance light absorbing materials have been attempted, but require a wide range of experimental techniques, which typically use different sample configurations and illumination levels thereby presenting additional complications in the analysis. Here, we demonstrate a carrier-resolved photo Hall technique that rests on a new identity relating hole-electron Hall mobility difference, Hall coefficient and conductivity. This discovery, together with advances in ac-field Hall measurement using a rotating parallel dipole line system, allows us to unlock a host of critical parameters for both majority and minority carriers. We successfully apply this technique to various light absorbers such as Si, $Cu_2ZnSn(S,Se)_4$, organometal lead halide perovskites, $(FA,MA)Pb(I,Br)_3$ and map the results against varying light intensities, demonstrating unprecedented simultaneous access to these parameters. This information, buried in the photo-Hall measurement, has so far been elusive for 140 years since the original discovery of Hall effect. Beyond historical significance, the applications of simultaneous majority and minority carrier measurement are broad, including photovoltaics, optoelectronics and various electronic devices.



Brief Bio: Byungha Shin is Associate Professor in the Department of Materials Science (MSE) and Engineering at Korea Advanced Institute of Science and Technology (KAIST) in Daejeon, Korea. Prof. Shin received B.S. in MSE from Seoul National University in 2000, M.S. in MSE from the University of Michigan in July 2002, and Ph.D. in Applied Physics from Harvard University in 2007. From May 2007 to March 2010, he was a post-doctoral researcher in the Department of MSE at Stanford University. From May 2010 until he joined KAIST in Feb 2014, he worked at IBM T. J. Watson Research Center in as a post-doctoral researcher and as a Research Staff Member. His past research experience includes study of thin film growth kinetics and high-k dielectric materials for microelectronic applications. His primary research interest is developing novel materials for energy applications with the current emphasis on hybrid perovskite optoelectronic devices (PV and LED), chalcogenide thin film solar cells, and photoelectrochemical water splitting.

Center for Integrated Nanostructure Physics IBS