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Hot Carrier Energy Harvesting and Conversion

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This issue of the *Journal of Photonics for Energy* features a special section on hot carrier energy harvesting and conversion, which includes papers that describe both fundamental aspects of hot carrier science and its application to devices aimed at photodetection and energy harvesting. In its most general sense, hot carriers are energetic charge carriers (electrons or holes) that have an energy in excess of what would typically be found for a charge carrier in thermal equilibrium with its surroundings. This phenomenon can occur from photon excitation of a single particle or through the excitation and interaction of several particles, which could establish a new energy distribution that mimics a Boltzmann distribution at an elevated, i.e., hot, temperature. These charge carriers can lead to phenomena that were not possible previously, including subbandgap semiconductor charge injection and enhanced chemical reaction rates.

The topic of hot carrier generation has a long history going back to early studies of the photoelectric effect by Heinrich Hertz (in the late 1800s) and Albert Einstein (in the early 1900s), and the effect has found its way into devices like the Gunn diode. However, recent advances in plasmonics have thrust hot carrier effects back into the spotlight. The field of plasmonics describes the coupled interaction of electromagnetic radiation and charge oscillations in a metal (or other highly doped material). When light is incident on a metallic nanoparticle or film, it is possible to excite charge oscillations and confine the electromagnetic wave close to the metal surface, resulting in a surface plasmon excitation. This excitation can decay into hot electrons (or holes). As our ability to generate and manipulate surface plasmons has improved, so has our ability to generate and detect hot carriers.

The papers in this special section represent a few of the recent directions in hot carrier science and engineering including applications to photodetectors, solar cells, and light-emitting diodes, as well as papers that outline future routes for enhancing the performance of these devices.

Jeremy N. Munday received his PhD in physics from Harvard University in 2008 and currently he is an assistant professor in the Department of Electrical and Computer Engineering at the University of Maryland, College Park. He is a recipient of the NSF CAREER Award, ONR YIP Award, the OSA Adolph Lomb Medal, the IEEE Photonics Society Young Investigator Award, the SPIE Early Career Achievement Award, and the NASA Early Career Faculty Space Technology Research Award.

Qiaoqiang Gan received his PhD in electrical engineering from Lehigh University in 2010 and currently is an assistant professor in the Department of Electrical Engineering at the University at Buffalo, The State University of New York. He is currently working on nanophotonic materials/structures for energy harvesting and conversion. He also served as an associate editor for *IEEE Photonics Journals* and *Scientific Reports*.