

8th International Conference and Exhibition on

MATERIALS SCIENCE AND ENGINEERING

May 29-31, 2017 Osaka, Japan

Optimal shell thickness for Al₂O₃-encapsulated Ag NPs for enhancing polaron generation in P3HT

Wei-Peng Goh

Technology and Research, Singapore

Surface plasmons are attractive as they have unique optical properties in the form of localized field enhancement and strong light scattering ability. As confined electromagnetic waves propagating at the metal/dielectric interface, surface plasmons can improve light absorption in a photoactive layer and hence, photogeneration of carriers. Localized electric field enhancement associated with surface plasmons can increase the optical path length of photons due to elevated scattering conditions. Introducing metallic nanoparticles in organic solar cells is known to improve charge carrier concentration. Localized field enhancement arising from surface plasmons is a possible mechanism. However, the presence of these nanoparticles in the organic layer introduces charge recombination sites. Charge recombination can be suppressed by coating a thin insulating layer around the metallic nanoparticles. Simultaneously, this insulating shell inhibits the extent that the localized field enhancement can influence charge generation in the organic layer. Hence, it is hypothesized that there is an existence of an optimal shell thickness that balances charge recombination with localized field enhancement. Different thicknesses of insulating shells in the form of Al₂O₃ were deposited onto 50 nm silver nanoparticles (Ag NPs) using Atomic Layer Deposition (ALD). A thin 25 nm P3HT layer was spincoated on top of the Al₂O₃-encapsulated Ag NPs. Using Photoinduced Absorption (PIA) spectroscopy, photogenerated P3HT⁺ polaron concentration as a function of Al₂O₃ thickness was investigated. An optimal shell thickness of 3-5 nm was obtained.

Biography

Wei Peng Goh obtained his BSc degree in Applied Science (Applied Physics) from the Royal Melbourne Institute of Technology University, Melbourne, Australia and MSc degree in Material Physics and Nanotechnology from Linköping University, Linköping, Sweden. He joined Institute of Materials Research and Engineering (IMRE), Agency for Science, Technology and Research (A*STAR), Singapore. He is currently awaiting his PhD degree (Materials Science and Engineering) from Nanyang Technological University, Singapore.

gohwp@imre.a-star.edu.sg

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