Unique Design of $CuInSe_2$ Nanocrystal decorated Gold Nanoprism Hybrid Conjugates for Advanced Photocatalytic Application

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We present $CuInSe_2$ nanocrystal decorated gold nanoprism hybrid conjugates with advanced photocatalytic ability in order to offer a unique and environmentally sound solution to the current obstacles faced by photovoltaic device materials currently used. A search for clean and abundant energy sources is a major concern for the environmentally conscious scientist. Photocatalytic reactions can harness this energy and use it for a variety of applications including oxidation of organic contaminants, self-cleaning glass, conversion to water as hydrogen glass, and decomposition of crude oil. However solar absorption in these devices is lacking the efficiency needed to be cost effective. Choice of device material is pivotal in overcoming this large hurdle. Materials such as TiO_2, the most commonly used semiconductor photocatalyst, for example only absorbs light in the ultraviolet region which accounts for less than 5% of total solar radiation. Hybrid conjugates, or nanomaterials combining semiconductor and metal materials, are a fast growing alternative to this problem. By incorporating localized surface plasmon resonance (LSPR) properties of the metal nanostructures with controllable band gaps of the semiconductor nanocrystals, the material can shift to the visible and near-infrared spectra thus allowing for greater solar absorbance. However, to the best of our knowledge, no reports are available in which plasmonic coupling occurs between a LSPR active metal nanostructures and the tailoring of the semiconductor nanocrystals' band gap by a non-toxic, low temperature synthesis. Hybrid conjugates between LSPR active metal nanostructures and semiconductor nanostructures have been reported but suffer from cost effectiveness and often use environmentally unfriendly chemicals. We believe our unique hybrid nanomaterial will allow for further tuning of the LSPR peak position in order to extend light absorption to a more optimal window and further excite electron-hole pairs in order to provide the most photocatalytic activity to date while providing an environmentally friendly and cost-effective approach. This work has major implications in clean energy and more specifically the advancement of photocatalytic applications.