Pt-Au-ZnO Hybrid Nanoparticles: An Efficient Photocatalyst for Environmental Applications

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The global human population is on the rise, consequently, a large amount of waste is being produced from various industries and vehicles, causing pollution of air, water and land at an intolerable rate. Illuminated semiconducting nanoparticles, such as ZnO and TiO_2 are promising materials for degradation of toxic organic contaminants in both liquid and gas phases. However, these nanomaterials can only utilize wavelengths below 400 nm emitted from the sun. Coupling of plasmonic nanoparticles such Au and Ag to semiconductors is a popular approach to extend the light absorption wavelengths to the visible region. Moreover, the localized surface plasmon resonance (LSPR) creates intensified electromagnetic fields that enhances the electron-hole separation in semiconductor particles. However, hybrid nanoparticles formed with plasmonic metal islands, such as Au, Ag and Cu exhibited lesser electron discharge than expected due to a process called Fermi level equilibration, where much of the electrons accumulated on the metal islands.[1] In contrast, hybrid nanoparticles formed with Pt metal islands have exhibited efficient electron discharge, where no electrons accumulated on the semiconductor or Pt deposit. However, Pt nanoparticles lack LSPR in the ultraviolet-visible region due to the damping effect of the d-d transitions in these metals. Therefore, to retain both LSPR and rapid electron discharge, a three component hybrid system such as Pt-Au-ZnO could be used. This study reveals a simple approach to synthesize Pt-Au-ZnO three component hybrid system. Improved photocatalytic properties of the new hybrid system will be presented.

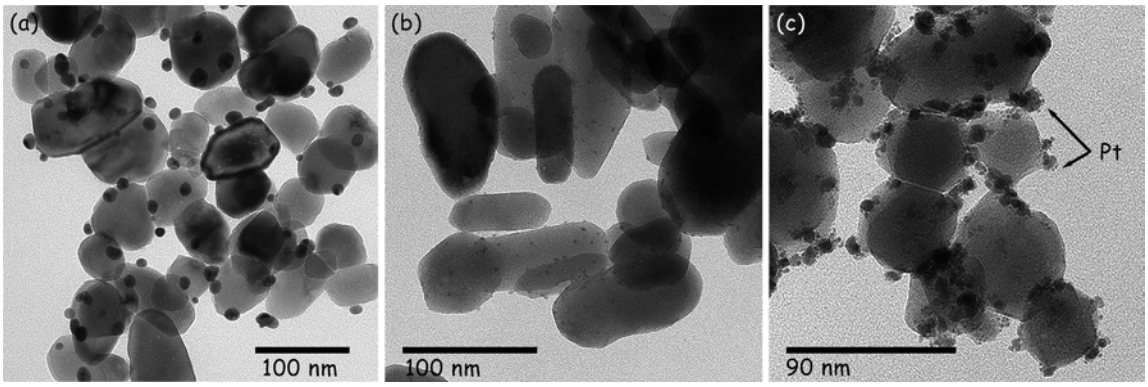

Figure 1: (a) TEM image of the as prepared Au-ZnO hybrid product. Au nanoparticles are ~10 nm in diameter. (b) TEM image of the as prepared Pt-ZnO hybrid product. (c) TEM image of the as prepared Pt-Au-ZnO hybrid product, where ~2 nm Pt nanoparticles are deposited on Au nanoparticles.

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References

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