Boosting visible-light-driven photocatalytic lignin model compounds cleavage with an integrated plasmonic metal Au/Ag-Ni(OH)$_2$ system

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Abstract:

Lignin is the most abundant renewable source in nature accounting for up to 40% by energy in bio mass. Conversion of lignin will release carbohydrate fractions and produce value-added chemicals. However, the depolymerization of lignin to aromatics is still a big challenge. High temperature, high pressure and expensive transition metal catalyst Ru, Rh, Pt, Pd are generally required. Thus, it would be a significant breakthrough if we can use economic way under mild condition to depolymerize this complex molecule.

Photocatalysis is a green and clean process which are able to drive reactions at mild condition. Herein, we report a novel photocatalytic system for lignin model cleavage by simply using nickel salts (such as $Ni(NO_3)_2$, $Ni(acac)_2$, $NiCl_2$ etc.) as the starting materials together with the supported Au or Ag nanoparticles (NPs) under visible light irradiation. In this study, Ni^{2+} in situ forms $Ni(OH)_2$ in the base condition and attaches onto the 3 wt.% Au or Ag supported on zirconium oxide. This integrated photocatalyst exhibits excellent activity for lignin model benzyl phenyl ether (α-O-4) cleavage under visible light irradiation at 40°C under 1 atm argon atmosphere, while no desired product yield in the dark under identical conditions. In addition, the present catalytic system can be applied in catalyze phenylethyl phenyl ether (β-O-4) and diphenyl ether (4-O-5) effectively. The conversion rate can be affected by tuning the light intensity and wavelength of irradiation. Meanwhile, the solid catalyst can be recycled and reused for several runs without adding further base.

Biographical Statement of speaker:

Xiayan Wu is currently a PhD student in QUT under Prof. Huaiyong Zhu. His research interests focus on exploring novel nanoparticle photocatalysts for organic synthesis. He got BEng in Materials Science and Engineering in China and Master of Metallurgy in UK and worked as metallurgist in Australia for seven years.