Stabilising the Au_9 Clusters at the TiO_2 Film using Chromium Oxide Layer Depends on the Stability of TiO_2 Film

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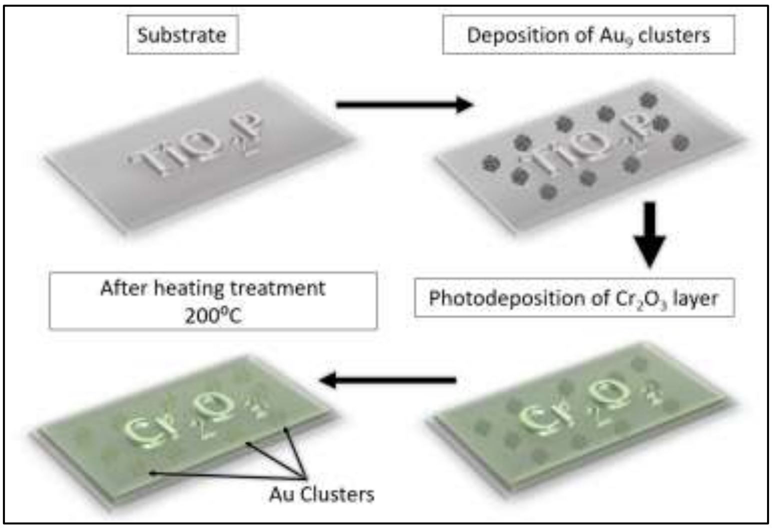

Abstract

Hydrogen is considered as one of the future energy sources. Hydrogen is a storable commodity and can be used fuel for a large range of applications. One possibility to produce hydrogen from renewable energy resources is photocatalytic water splitting. This process requires a photocatalyst with a minimum bandgap, which is estimated to be around 1.6 eV(Wang and Domen 2020). The efficiency of photocatalysts can be enhanced by using co-catalysts(Kurashige, Kumazawa et al. 2018). Stabilising chemically synthesised gold clusters on a metal oxide surface without agglomeration is a major challenge(Metha, Andersson et al. 2019). We have investigated the stability of phosphine-stabilised clusters $Au_9(PPh_3)_8(NO_3)_3$ (Au_9) on TiO_2 films by depositing a Cr_2O_3 over-layer. Two different thicknesses of TiO_2 films were used in this study; TiO_2P and TiO_2G. Both were made using the radio-frequency sputtering technique. The TiO_2 film thickness for TiO_2P and TiO_2G is ~ 400 nm and 1100 nm. X-ray photoelectron spectroscopy was used to determine the chemical composition and electronic structure of the surface. The thickness of TiO_2 films was imaged by scanning electron microscopy. The crystallinity and the surface topography of TiO_2 films were characterised using x-ray diffraction and laser confocal microscopy. Au_9 clusters were successfully stabilised on the surface of the TiO_2P film; however, Au_9 clusters agglomerated at the surface of TiO_2G. The agglomeration of Au_9 clusters in the latter is due to the high mobility of TiO_2G film during the heating treatment to remove the ligands.

Metha, G. F., et al. (2017). Photocatalytic conversion of carbon dioxide and water into substituted or unsubstituted hydrocarbon(s)WO Patent App. 2016/051175.

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