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Raspberry-like Cr_2O_3-TiO_2 Core-Shell Microspheres for CO_2 Photoreduction

Jeannie Z. Y. Tan, Meltiani Belekoukia, Jin Xuan, M. Mercedes Maroto–Valer.
Research Center of Carbon Solutions (RCCS), School of Engineering & Physical Sciences, Heriot-Watt University, Edinburgh, United Kingdom.
**Corresponding author: j.tan@hw.ac.uk*

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The photocatalytic conversion of CO_2 into useful chemical compounds in the presence of H_2O is a very promising solution to overcome global environmental and energy problems. To promote the photocatalytic conversion of highly stable CO_2 into hydrocarbons, such as CO, methane, etc., a reductive semiconducting material that falls within the reducing potential of CO_2 is required, with *p*-type semiconductors being of great interest. Cr_2O_3 has been one of the few *p*-type semiconducting metal oxide on the earth with double optical absorption band at 450 and 600 nm, respectively.[1] When the *p*–Cr_2O_3, which acts as the visible light absorber and provides the reductive site, was coupled with the *n*–TiO_2, which serves as the oxidative site and the UV absorber, a *p*–*n* heterojunction was formed with separated sites for the photocatalytic redox reaction.
A highly crystallized raspberry-like Cr_2O_3 was prepared through the facile hydrothermal method. Then, a thin layer of TiO_2 (~8 nm), which was evidenced from the line scan of EDS equipped with HRTEM (Figure 1), was coated on the Cr_2O_3 surface and calcined at various temperatures ranging from 400-850 ° C, resulting in core-shell Cr_2O_3-TiO_2 microspheres. The XRD and XPS studies revealed that the Cr^{3+}, Ti^{4+} and O^{2-} were the major elements within the synthesized composite. Due to the thin layer of TiO_2, the XRD pattern that could be assigned to TiO_2 was not observed. Hence, Raman spectroscopy was utilized to identify the crystal phase of TiO_2. The Raman spectra showed that the presence of Cr-O-Ti could be enhanced with increasing calcination temperature above 700 °C.
The CO_2 photoreduction performance of the Cr_2O_3-TiO_2 composites was greatly enhanced when compared to the pristine Cr_2O_3 due to the formation of the interaction of Cr-O-Ti, as evidenced by the Raman spectra. The optimized Cr_2O_3–TiO_2 sample produced the maximum of ~160 µmol g^{-1} h^{-1} under the irradiation of UV light.

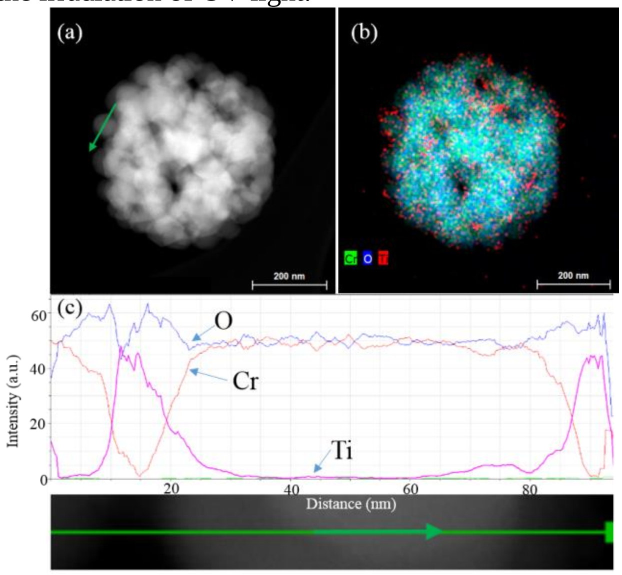

Figure 1. TEM (a) and EDS mapping (b) of Cr_2O_3–TiO_2 microsphere. Line scan spectrum of one of the Cr_2O_3–TiO_2 nanoparticles (green arrow) within the microsphere (c).

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References

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