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Premixed Stagnation Flame Synthesized TiO_2 Nanoparticles with Mixed Phases for Efficient Photocatalytic Hydrogen Generation

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Mixed-phase TiO_2 nanoparticles (10-20 nm) composed of rutile, anatase and srilankite phases are prepared through a one-step flame synthesis method. The phase composition of TiO_2 nanoparticles can be easily tuned by changing the flame conditions such as the gas flow rates of the fuel, oxygen and argon carrier. The optimized anatase/rutile/srilankite TiO_2 sample with as low as 0.1 wt% of Pt co-catalyst exhibits remarkable photocatalytic H_2 generation rate of 21.9 mmol h^{-1} g^{-1} and an apparent quantum efficiency (AQE) of 39.4% at 360 nm, higher than those of anatase/rutile or anatase TiO_2. The less studied srilankite phase is first time investigated for photocatalytic H_2 generation. It is revealed that the relatively low content of srilankite phase in TiO_2 could efficiently promote charge separation and transportation. It is remarkable that compared to the commercial P25 TiO_2, the flame made TiO_2 significantly improves Pt reduction and dispersion owing to the oxygen vacancies and surface defects. The optimized TiO_2 sample with surface defects facilitates the deposition of ultra-small Pt nanoclusters of around 0.63 nm and stabilizes the low valence state of Pt^0, leading to efficient utilization of noble metal and remarkable enhancement of H_2 generation rate.

Biography:

Shuyang Wu is a current PhD student in School of Chemical and Biomedical Engineering, Nanyang Technological University, Singapore. His main research interest lies in the area of flame synthesized metal oxide for the applications in energy and environment, including photocatalytic hydrogen generation, CO_2 reduction and volatile organic compounds degradation.