

## **Photocatalytic Hydrogen Generation on Low-Bandgap Monoclinic-Tetragonal ZrO<sub>2</sub> Hetrostructures Stabilized by High-Pressure Torsion**

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Hydrogen is considered as a clean energy carrier for future application, but production of hydrogen without emitting CO<sub>2</sub> is still challenging. The production of hydrogen from renewable energy sources is the main challenging task in hydrogen energy studies. Production of hydrogen from solar energy by photocatalytic reactions is considered as a main alternative for future hydrogen production.

Despite the remarkable features of common photocatalysts (TiO<sub>2</sub>, ZnO and perovskites), there exist certain associated drawbacks such as faster charge carrier recombination, low photo-induced reaction efficiency and rapid deactivation due to the accumulation of less reactive by-product on the photocatalyst's surface. Theoretical studies suggested that high-pressure phases, inter phase junctions and vacancies of some photocatalysts have low bandgaps and better electronic excitation. High-pressure torsion (HPT) method is an effective method to stabilize high-pressure phases and vacancies at ambient pressure. In this method, high pressure and large torsional strain are simultaneously introduced to the material and change the thermodynamics and stabilizes different high-pressure phases and vacancies at ambient condition. Herein, monoclinic-tetragonal ZrO<sub>2</sub> hetrostructures with oxygen vacancies is stabilized by HPT method at ambient pressure to enhance the photocatalytic hydrogen generation under ultraviolet (UV) and/or visible light. Phase transformation and bandgap narrowing is confirmed in ZrO<sub>2</sub> after HPT processing. Our preliminary results also show that photocatalytic activity of ZrO<sub>2</sub> after HPT processing is improved.