Smart Functionalization of SiO_2 and TiO_2

Keywords: silica · titania · adsorption · photocatalysis

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Background

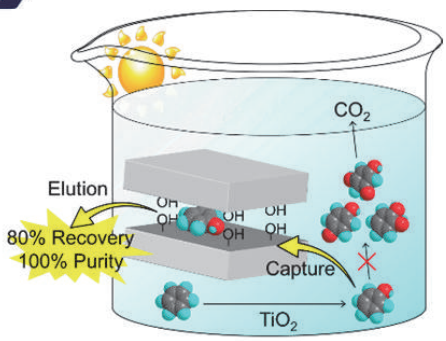
- Silica and titania are widely studied owing to their low-cost, safety and materials diversity.
- Their performances should still be improved for practical applications.
- Other related materials are gaining more attention recently.

Aim

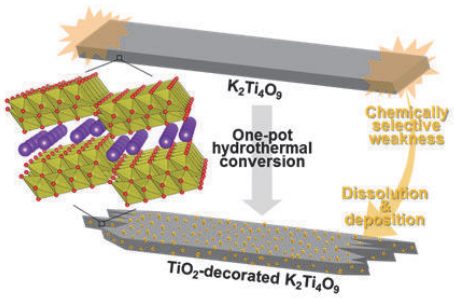
- Development of new silica and titania materials (design).
- Development of operation environment to attain high performances even on commercial materials.
- High performances even on silica and titania depending how they are used.

Advanced Research Topics

✓When the partial oxidation of benzene to phenol, which is one of the most important reactions in chemical industry, was conducted using TiO_2 in the presence of a phenol-philic layered silicate adsorbent, phenol was recovered in unprecedentedly high yield and purity.[1] This resulted from the fact that the adsorbent captured the generated phenol promptly, selectively, and effectively to prevent the overoxidation, after which the captured phenol could be easily eluted.



✓We have applied "zeolite conversion", a recently burgeoning hydrothermal synthetic method to design zeolites, to titania nanoparticles/layered titantaes.[2] When $K_2Ti_4O_9$ nanobelts were exposed to similar hydrothermal conditions, in contrast to the previous studies,[2] the edges of the nanobelts selectively dissolved and recrystallized into anatase nanoparticles, forming heterostructure photocatalysts that retained the cation exchange ability of the original titanate but also possessed the enhanced charge separation efficiency.[3] This heterostructure efficiently photo-reduced aqueous metal cations (fixation of metals for safe disposal), whereas $K_2Ti_4O_9$ and the benchmark TiO_2 showed little to no activity.



Publications

- Ex., *J. Am. Chem. Soc.* **2013**, *135*, 11784.
- Ex., *J. Mater. Chem. A* **2014**, *2*, 16381; *Angew. Chem. Int. Ed.* **2016**, *55*, 3600; *Chem. Commun.* **2018**, *54*, 381.
- *Inorg. Chem.* **2018**, *57*, 6045.

Summary

- Fine chemical synthesis by a new photocatalytic system composed of commercial TiO_2 and naturally occurring layered silicate adsorbent.
- Photo-fixation of metal ions on layered titanate heterostructures.

Research outcome

- g- or mol-scale fine chemical synthesis.
- Fast fine chemical synthesis.
- Ultra-first photo-fixation (cation exchange and photo-reduction) of metal ions.