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Spectrally selective multi-layer films with synergistically enhanced photocatalytic and solar light modulation properties

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Spectrally selective multilayer films that exhibit synergistically enhanced photocatalysis, solar light modulation and luminous transmittance can be made by combining thin films in layered stacks with complementary optical and structural properties. It is here demonstrated that dramatically enhanced photocatalytic properties can be achieved by combing thin anatase TiO_2 films with solar light absorbing and thermochromic films in a bilayer configuration. We present two case studies: TiO_2/VO_2 and TiO_2/TiAlN bilayer films made by reactive dc magnetron sputtering. The TiO_2/VO_2 bilayer exhibits enhanced near-infrared light absorption, which thereby heats the TiO_2 film by more than 30 degrees, resulting in an almost 2-fold increase of the reaction rate for photo-degradation of stearic acid layers. Importantly, the TiO_2/VO_2 bilayer stack also exhibits anti-reflective properties, and enhanced solar modulation (~ 9%) compared to VO_2, and ~ 20% increased solar absorptance compared to TiO_2, thus realizing a truly spectral selective coating that utilizes the whole solar spectrum. In the second example, bilayer TiO_2/TiAlN films yielded an almost 10-fold enhancement of the quantum yield for acetaldehyde removal (on par with state-of-the-art, heterojunction photocatalysts), and an associated temperature rise larger than 120 degrees. Both findings can be understood by thermal activation to the increase the surface reaction kinetics, where water desorption from the oxide plays and important role. We generalize the results, and discuss their implications in CleanTech for air cleaning, self-cleaning and possible scenarios for their implementation.

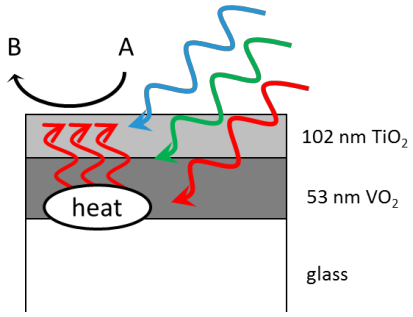

Figure.1 Principle of spectral selective multilayer coatings with enhanced (i) photocatalytic activity, (ii) thermochromic and (iii) anti-reflective properties.

References

Lars Österlund et al., Spectrally selective heat absorptive bilayer photocatalyst with enhanced reactivity: TiO_2/TiAlN, Topics in Catalysis, 61, 1607–1614 (2018).

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