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](image)

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

References

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