Novel multi-functional self-cleaning, air cleaning and thermochromic films for the built environment

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Spectrally selective photocatalytic multilayer films that exhibit dramatically enhanced photochemical reactivity upon solar light activation were fabricated. It is shown that synergistically enhanced physciochemcial properties can be achieved the surpass those of the constituting single-layer films. We present two case studies: TiO2/VO2 and TiO2/TiAlN bilayer films made by reactive dc magnetron sputtering. The TiO2/VO2 bilayer exhibits enhanced near-infrared light absorption, which thereby heats the TiO2 film by more than 15 degrees, resulting in an almost 2-fold increase of the reaction rate for photo-degradation of stearic acid layers. In addition, the TiO2/VO2 bilayer stack exhibited anti-reflective properties, and enhanced solar modulation (~ 9%) compared to VO2, and ~ 20% increased solar absorptance compared to TiO2. In the second example, bilayer TiO2/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 for green building technology and possible scenarios for their implementation.



Fig.1 Principle of a spectral selective TiO2/VO2 multilayer coating on glass with enhanced (i) catalytic activity, (ii) thermochromic and (iii) anti-refelctive properties.

References

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