Nanothermochromics for Energy Efficient Fenestration

Claes G Granqvist

Department of Engineering Sciences, The Ångström Laboratory, Uppsala University, Uppsala, Sweden

e-mail: claes-goran.granqvist@angstrom.uu.se

Thermochromic technology can be employed for regulating the solar energy throughput in “smart” windows with the object of achieving energy efficiency in buildings. Thin films of vanadium dioxide (VO_2) give an appropriate starting point for developing this functionality; they have a significantly higher infrared transmittance below a “critical” temperature τ_c than above this temperature as a result of a reversible structural transformation. However VO_2 films cannot be used without modification for three main reasons: (*i*) the modulation of solar transmittance ΔT_{sol} is too small at τ_c, (*ii*) the luminous transmittance T_{lum} is too low, and (*iii*) τ_c is ~68 °C and hence too high for normal buildings-related applications. I describe how these three problems can be met to a large degree and thus how thermochromic fenestration for energy efficient buildings can come closer to practical realization. In particular, I discuss how nanothermochromics—involving VO_2-based nanoparticle composites rather than thin films—make it possible to significantly improve ΔT_{sol} as well T_{lum}, how magnesium doping of VO_2 can give further enhancements of T_{lum}, and how tungsten doping (and to some extent also magnesium doping) can bring τ_c to a normal comfort temperature. Finally, I outline how thermochromics may be combined with electrochromics and vacuum insulation in order to create novel “super fenestration” for buildings with radically improved energy performance and a high degree of indoor comfort.