

# Flexible one-dimensional photonic crystals based on nanoparticle multilayers for ultraviolet radiation protection purposes.

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A novel flexible one-dimensional photonic crystal as selective ultraviolet (UV) reflecting mirror is presented[1]. A periodic multilayer structure is formed by spin-coating deposition of colloidal suspensions of nanoparticles of  $\text{ZrO}_2$  and  $\text{SiO}_2$  (electronic band gap at  $\lambda < 220$  nm). These UV filters are designed to shield against precise wavelength ranges of the UVA, UVB, and UVC regions of the electromagnetic spectrum while maintaining transparency in the visible. The protection against those spectral regions takes place entirely from optical interference phenomena and is related exclusively on the number of stacked layers and the refractive index contrast between them. Moreover, it is shown[2] that the inter-connected pore network of the as-deposited multilayer permits preparing thin, flexible, self-standing, transferable, and adaptable selective UV filters by polymer infiltration, without considerably losing reflectance intensity, i.e., keeping the dielectric contrast high. These films present a level of protection equivalent to that of conventional ones[3], without any expected undesired secondary effects, such as photodegradation, increment of local temperature or, as is the case for organic absorbers, creation of free radicals, all of which are induced by light absorption.

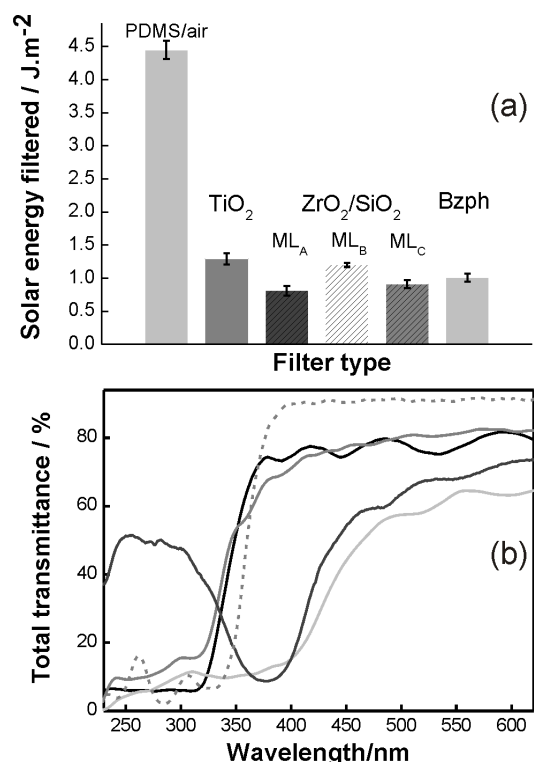
## References

[1] J.R. Castro Smirnov, M.E. Calvo, H. Miguez, *Adv. Funct. Mater.* **2013**, DOI: 10.1002/adfm.201202587

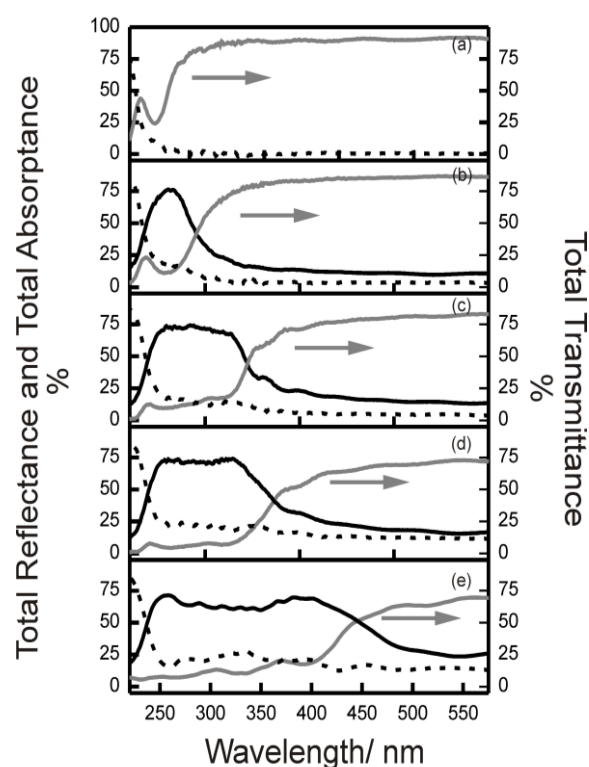
[2] M.E. Calvo, H. Miguez, *Chem. Mater.*, **22**, (2010), 3909–3915

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## Figures



**Figure 1.** (a) Energy received by identical UV sensitive strips covered with different flexible protective films. Height of the bar represents the media value, black line represents the standard deviation.  $\text{ML}_A$ ,  $\text{ML}_B$ ,  $\text{ML}_C$  belong to different  $\text{ZrO}_2/\text{SiO}_2$  films. (see figure 6b)(b) Total transmittance spectra of the protecting films used in Figure 6a.  $\text{TiO}_2$  (black solid line),  $\text{ML}_A$  (light gray solid line),  $\text{ML}_B$  (grey solid line),  $\text{ML}_C$  (dark grey solid line), benzophenone-3 (grey short dashed line).



**Figure 2.** Total reflectance (black solid line), total transmittance (grey solid line) and absorbance (black dotted line) spectra of stacking flexible films prepared from samples shown in figure 4a. The number of stacking samples is 1