High Diffuse Solar Reflectance with a Polytetrafluoroethylene (PTFE) Sheet on a Silver Film

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Daytime cooling, which aims at reducing the temperature rise under sunlight, is an active research area that holds great potential for applications such as building thermal management, energy saving, etc. To achieve daytime cooling requires a type of material with both high solar reflectance and broadband infrared emissivity, among which the high reflectance in the solar irradiation region (from 0.28 to 4.0 mm) is extremely important since it can exceed 1000 W/m^2. Here, we present a design of a dual-layer solar reflector made of polytetrafluoroethylene (PTFE) sheet on top of a silver film: very high diffuse reflectance can be achieved over the entire solar spectrum. Spectral reflectance and transmittance of the PTFE sheets (with and without a Ag film) are measured using a monochromator and a Fourier-transform infrared spectrometer (FTIR), with integrating spheres, at wavelengths from 0.28-15 mm. The scattering and absorption coefficients of the PTFE samples were obtained by fitting the reflectance and transmittance spectra. Integration over the solar irradiation spectrum (AM1.5) reveals that the total solar reflectance is approximately 99 % for all three PTFE sheets (with nominal thicknesses of 0.25, 0.5, and 1 mm) on a Ag film. This is the highest solar reflectance value reported to date. We use a Monte Carlo ray-tracing method and the simple two-flux model to calculate the reflectance, compare with the experiments and explain the underlying mechanisms enabling the high reflectance. It is also shown that PTFE has a high emittance of around 90 % in the mid-infrared region from 8-13 mm, the atmospheric window. Therefore, the proposed structure holds promise for passive daytime radiative cooling under the sunshine.