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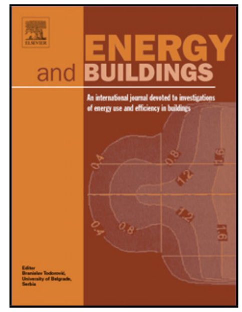

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Methods and instrumentation to measure the effective solar reflectance of fluorescent cool surfaces

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Highlights

1. Near-infrared fluorescence can help dark surfaces stay cool in the sun.
2. Fluorescent re-emission contributes to effective solar reflectance (ESR).
3. Radiometric and calorimetric methods of ESR measurement are explored.
4. Mitigating wind-induced noise is key to calorimetric techniques.
5. Rotary calorimetric instrument measures ESR with repeatability of ± 0.02.

ABSTRACT

Fluorescent cool dark surfaces stay cool in the sun by reflecting near-infrared (NIR) irradiance and by actively emitting in the NIR spectrum some of the energy absorbed from visible sunlight. The fraction of incident solar energy rejected by reflection and fluorescence is the “effective solar reflectance”, or ESR, of the surface.

It is challenging to measure ESR with a solar spectrometer or a solar reflectometer, the radiometric instruments most commonly used to measure the solar reflectance (SR) of specimens in the laboratory. We have tested a variety of calorimetric techniques for using temperature in the sun to interpolate the effective solar absorptance (1 – ESR) of a fluorescent test specimen from the known solar absorptances of non-fluorescent reference specimens. Our experiments show that averaging out noise in the temperature signal induced by variations in convection is key.

We developed a computer-controlled rotary apparatus that compares the temperatures in the sun of up to six specimens. Trials on six different fluorescent specimens indicate that it can measure ESR with a repeatability of about 0.02. To maximize the ratio of signal to noise in temperature determination, and to facilitate calculation of the fluorescence benefit (ESR - SR), measurements should be performed with specimens facing the sun.