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Design of a Novel Energy-Saving Radiative Cooling Bilayer Paint for Space Cooling

Space cooling is a significant global end-use of energy and a major driver of peak electricity demand. The accumulation of heat from the sun during daytime increases the indoor temperature of buildings, which necessitates air conditioning. In order to reduce cooling demand, solar reflective white paints have been used to reduce solar heating. However, current reflective paints have intrinsically high near-infrared absorption, contributing to its heat gain. In this project I create and demonstrate the properties of a novel bilayer paint with a metal reflective layer underneath a high IR-emissivity white paint. Taking advantage of (1) radiative cooling by maximizing emissivity in the mid-infrared and (2) reflective cooling by maximizing solar reflectance, the bilayer paint serves to reduce solar heating while maximizing radiative cooling power. A temperature measurement of the bilayer paint after direct sun exposure revealed a consistent ~0.5°C decrease in surface temperature of the bilayer paint as compared to a commercial solar reflective white paint. Spectroscopic characterization of the bilayer paint showed much improved near-infrared reflectance as well as retention of high emissivity in the mid-infrared. Calculated from the spectroscopic characterization, the bilayer paint displayed significant ~7 W/m^2 more cooling power than the commercial paint ($t = 4.06$, $\alpha = 0.01$, $t\_crit = 3.14$). This study proved the effectiveness of a novel bilayer paint for building energy savings. Previously unexplored in literature, the bilayer paint provides a novel cooling roof technology which can serve to reduce cooling energy demand during the summer time.