Dust-Repellent and Self-Cleaning Coatings for Solar Panels on Earth, the Moon and Mars (Year Two)

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Solar energy is one of the most prominent sustainable sources of global energy while also powering space exploration. However, the efficiency of solar panels is undermined by the accumulation of charged dust particles. This project aims to reduce this issue by developing a long-term, self-cleaning coating that can be applied to solar panels to prevent dust from accumulating on the surface while maintaining transparent and anti-reflective properties. Based on last year's research, indium tin oxide (ITO) proved to be an effective coating due to its conductive properties, proving the concept of dust-repellent coatings. Building on these results, I explored a new transparent coating, spin-coated octadecyltrichlorosilane (OTS), which creates a hydrophobic yet conductive surface. Due to the lotus leaf effect, the hydrophobic and conductive coating causes water droplets to roll off with the remaining dust particles when it rains. Additionally, I improved both a chamber that blew Martian, Lunar, and Terrestrial dust simulants onto the coated sheets, simulating wind conditions, and a Python code that analyzed the coated sheets to estimate the dust coverage. Using a goniometer, I measured the static and dynamic contact angles of the coatings. The OTS-ITO coated sheet successfully prevented dust buildup, while being self-cleaning and maintaining the efficiency of the solar panel by avoiding light reflection. In addition to helping improve solar panels on the Earth, Mars, and the Moon this novel coating can also be applied to other surfaces such as windows, glasses, and screens to create dust-free and self-cleaning surfaces.

Awards Won:
China Association for Science and Technology (CAST): Award of $1,200