Development of Anti-Dust Nanostructured Silicon Dioxide Coating for Solar Cells

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Driven by the effects of global warming and environmental pollution from fossil fuel use, the transition towards renewable energy sources, such as wind and solar power, is gaining momentum. Yet, photovoltaic systems encounter critical issues, primarily due to soiling or dust accumulation, which can diminish power efficiency by 20-40% and raise maintenance expenses. Therefore, this study aims to develop a durable, transparent, environmentally friendly, and cost-effective anti-dust coating for photovoltaics, evaluating its potential to maintain PV power performance under harsh environmental conditions. The coating was applied using the dip-coating method, followed by heat curing to improve adhesion. Microstructural analysis using XRD, SEM, and EDS showed that the coating consists of SiO2 nanograins. The one month current-voltage (I-V) measurement test showed that coated samples had a higher Maximum Power Point by 8.7% and Open Circuit Voltage by 5.3% than uncoated ones. Transmittance evaluations over seven months showed that coated samples maintained a high level of transparency at 94% under clean conditions. Coating durability was confirmed through abrasion tests, where the coating withstood 30 cycles, a figure among the highest recorded for silicon dioxide coatings. The UV resistance and chemical stability tests further demonstrated robustness against environmental stressors. Additionally, a notable increase in cost efficiency ($1.5/kg) over conventional cleaning methods was observed, attributed to the coating's low-maintenance nature. In conclusion, this coating significantly benefits the solar energy industry by maintaining photovoltaic panel efficiency and substantially reducing cleaning costs, bridging the gap between innovative research and practical applications.

Awards Won:
King Abdulaziz &amp
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King Abdulaziz &amp
his Companions Foundation for Giftedness and Creativity: Mawhiba Universal Enrichment Program awards (and a $200 cash prize)
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