Luminescent Solar Concentrator Containing Parylene-C Microfibrous Thin Film Infiltrated With Lumogen F Red 305

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The urgent need to mitigate climate change necessitates a shift from fossil fuels to renewable energy sources. Solar energy, as the most abundant and cleanest renewable energy, offers a promising solution by converting sunlight into electrical power. Despite significant advancements in photovoltaic solar cells (PVSCs), the efficiency and cost-effectiveness of solar energy systems can be further improved. Luminescent Solar Concentrators (LSCs) enhance solar energy utilization by concentrating sunlight onto smaller, high-efficiency PVSCs, reducing material costs and increasing power output.

LSCs were made by the infiltration of microfibrous thin films (μFTFs) of Parylene C by Lumogen F Red 305 (LFR305), in order to maximize the concentration of light made available to a PVSC. The Parylene-C μFTFs with either tilted columnar or chevronic morphology were fabricated using physicochemical vapor deposition and infiltrated with LFR305 using thermal evaporation. The morphology of the fabricated Parylene-C μFTF was examined using field-emission scanning electron microscopy. Profilometry data indicated almost complete infiltration of LFR305. Optical measurements, including specular reflectance and transmittance, and photoluminescence, were conducted to assess the performance of the LSCs. Application of a voltage across a photoresistor illuminated by a solar simulator (AM1.5) through an LFR305-infiltrated Parylene-C LSC resulted in an enhancement of the ON-OFF minimum current ratio by a factor of 1.5 ± 0.29 compared to the ratio before LFR305 infiltration/deposition, regardless of morphology; furthermore, LFR305 infiltration enhanced the ON-OFF minimum current ratio by $56.5 \pm 21.5\%$, depending on the morphology. The LSC concentration factor, depending on the morphology, was determined to be 8.7 ± 3.4 after integration with a monocrystalline-silicon solar cell. This highlights the potential for significant improvements in solar energy conversion efficiency using these novel LSCs.