Low Mass Printable Devices for Energy Capture, Storage, and Use for Space Exploration Missions

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Abstract

The energy-efficient, environmentally friendly technology that will be presented is the result of a Space Act Agreement between NthDegree Technologies Worldwide, Inc., and the National Aeronautics and Space Administration's (NASA's) Marshall Space Flight Center (MSFC). This work combines semiconductor and printing technologies to advance lightweight electronic and photonic devices having excellent potential for commercial and exploration applications, and is an example of industry and government cooperation that leads to novel inventions. Device development involves three energy generation and consumption projects: 1) a low mass efficient (low power, low heat emission) micro light-emitting diode (LED) area lighting device; 2) a low-mass omni-directional efficient photovoltaic (PV) device with significantly improved energy capture; and 3) a new approach to building supercapacitors. These three technologies — energy capture, storage, and usage (e.g., lighting) — represent a systematic approach for building efficient local micro-grids that are commercially feasible; furthermore, these same technologies will be useful for lightweight power generation that enables inner planetary missions using smaller launch vehicles and facilitates surface operations. The PV device model is a two-sphere, light-trapped sheet approximately 2-mm thick. The model suggests a significant improvement over current thin film systems. All three components may be printed in line by printing sequential layers on a standard screen or flexographic direct impact press using the three-dimensional printing technique (3DFM) patented by NthDegree. MSFC is testing the robustness of prototype devices in the harsh space and lunar surface environments, and available results will be reported. Unlike many traditional light sources, this device does not contain toxic compounds, and the LED component has passed stringent off-gassing tests required for potential manifesting on spacecraft such as the International Space Station. Future exploration missions will benefit from "green" technology lighting devices such as this, which show great promise for both terrestrial use and space missions.