OBJECTIVE AND SIGNIFICANCE: The objective of this research is to develop high-throughput ink-based fabrication techniques for light-weight thin film photovoltaics (PV). This approach has the potential to significantly reduce manufacturing costs and enable PV integration on non-conventional substrates, such as polyamides or woven fabrics.

BACKGROUND: Crystalline silicon has been leading the PV market for over 20 years. These panels, found on roof-tops and in centralized production plants, are easily recognizable by their architecture, with interconnected wafer-like solar cells laminated under a flat sheet of glass. Although well-suited for stationary electrical production, the mechanical rigidity and weight of silicon PV modules become a burden for mobile applications, where portability is far more critical than raw performance. To this regard, R&D efforts have been recently focused on methods to integrate ultra-light and flexible thin film solar materials onto lightweight/flexible substrates, including plastics (polyamides) and fabrics. Such devices can generate enough electricity to power small electronic devices (phones and electronic tablets for civilians) and sensors (healthcare diagnosis instruments for military personnel), providing a reliable source of energy for a variety of military and commercial applications.

PROJECT STATUS/RESULTS: With support from the Office of Naval Research, the research team at the HNEI/Thin Films Laboratory is developing a unique method to print thin film-based PV. Rather than relying on conventional vacuum-based deposition tools, which are costly to operate and maintain, this technique uses liquid molecular inks which already contain all the chemical elements necessary for the synthesis of the solar absorber. These inks can be easily printed and cured to form thin film solar absorbers. Our project is currently focused on an Earth-abundant multi-compound alloy (Cu₂ZnSnSe₄, CZTSe), a material which meets the mechanical and weight requirements for lightweight flexible PV. Results of this work show that high-quality CZTSe solar absorbers can be achieved with this printing technology. Solar cells with power conversion efficiency over 7% have been fabricated. However, CZTSe has the potential to achieve much higher efficiency, up to 20%.

Current work focuses in development of innovative techniques to passivate defects in CZTSe solar absorbers and improve their conversion efficiency (primarily increase cells output voltage). This technique is also being evaluated to synthesize other solar absorbers with promising properties for PV applications, including Cu(In,Ga)Se₂ and Cu(In,Al,B)Se₂.

Funding Source: Office of Naval Research

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Last Updated: October 2020