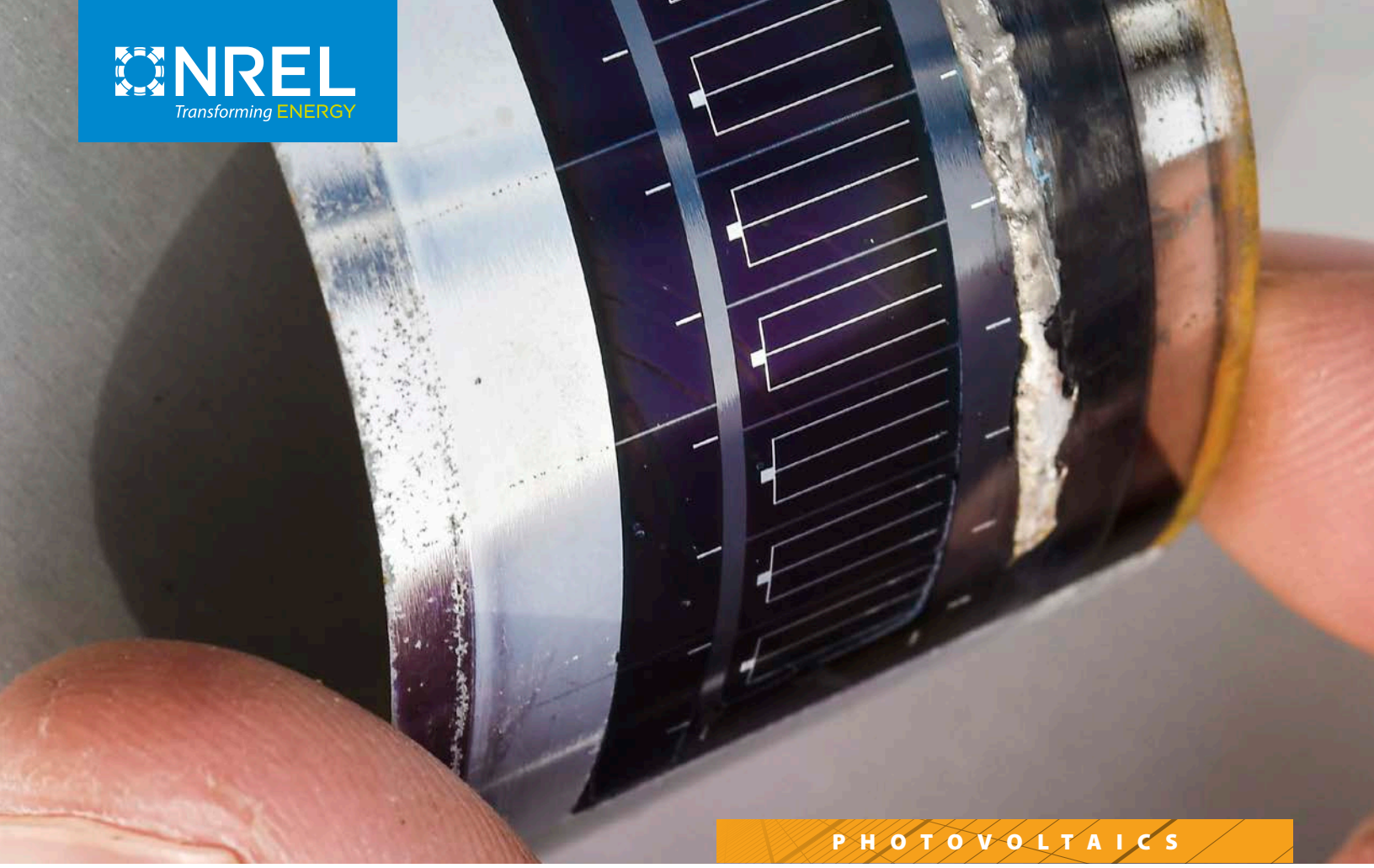

Thin-film, lightweight Cu(In,Ga)Se_2 photovoltaic cell on flexible stainless steel. *Photo by Dennis Schroeder, NREL 53336*

Polycrystalline Thin-Film Research

Copper Indium Gallium Diselenide

Copper indium gallium diselenide (CIGS) solar cells are one of the primary research focuses of the Thin-Film Materials Science and Processing Group. The group develops processes and materials related to thin-film polycrystalline photovoltaic (PV) devices as well as the equipment required for routine analysis of these devices and materials. We work closely with other groups in the Materials Science Center to achieve a deeper understanding of thin-film materials and devices.

Core Competencies and Capabilities

Our CIGS thin-film PV effort is recognized worldwide. Key accomplishments include the development of processes, know-how, and intellectual property that have led to highly efficient CIGS thin-film technology. We have held many world records for CIGS energy conversion efficiency. Our ultimate goal is to lower the manufacturing cost of CIGS PV products. Thus, research projects currently underway tackle issues to improve CIGS processes and material quality control as well as the long-term stability and reliability of CIGS devices, and we search for new and alternative materials that can lead to a lower cost per watt figure. We also collaborate with U.S. industry on specific topics of interest to the customer (e.g., unique substrates, comparative studies to optimize industrial processes, and scale-up).

PV thin films such as lightweight, flexible CIGS can provide power for rapidly deployed, temporary military command centers.
Photo from Global Solar Energy

We have specific capabilities in various areas are listed below:

- Substrates
  - Soda-lime glass
  - Na-free glass and ceramics
  - Metal foils
  - High-temperature plastics
- Cleaning
  - Various aqueous cleaning processes
  - High-speed spin rinse
- Mo Layer
  - Sputtering Mo
  - Various adhesion layers (e.g., Cr, Ni)
  - Mo patterning
- CIGS Layer
  - 4-source co-evaporation
  - Various processes (e.g., 3-stage, 2-step selenization)
- CdS and Zn(O,S) Layers
  - CdS and Zn(O,S) by chemical bath deposition, atomic layer deposition, sputtering
- Window Layers
  - Undoped ZnO by metal-organic chemical vapor deposition (MOCVD) or sputtering
  - ZnMgO by MOCVD or sputtering
- Transparent Conductive Oxide Layer
  - ZnO:Al or ITO by sputtering
- Interconnects
  - Metallization for top-contact grids
  - Monolithic interconnection
- Antireflection Coating Layer
- Alkali Incorporation (e.g., Na, K, Rb)
  - From glass
  - Precursor
  - Post-deposition treatment
- Cell-Level Reliability Testing
  - Metastability
  - Partial shading damage
  - Potential-induced degradation

Our capabilities in research and development are directed at materials that may have significant advantages for improved thin-film PV performance, reduced use of scarce and/or expensive constituents, and improved environmental stability. Furthermore, they may demonstrate opportunities for advancing fundamental knowledge in this important technology area.

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