International Advanced Research Centre for Powder Metallurgy & New Materials (ARCI)

Balapur P.O., Hyderabad – 500005, Telangana, India

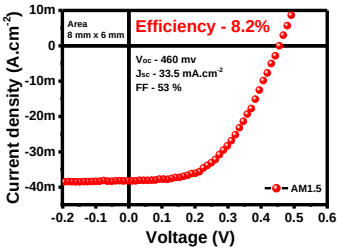
Development of CIGS thin film solar cells and monolithically integrated modules

Overview

Due to reduced material and energy input thin-film provides still advantages compared to crystalline silicon-based PV technologies. In terms of cost per watt and efficiency of Cu(In,Ga)Se_2 (CIGS) solar cell is considered to be the most promising thin-film PV technology. The efficiency evolution of CIGS during the last few years has been the most impressive within the thin-film materials, moreover comparable to multi-crystalline silicon cells and even more efficient than amorphous silicon (a-Si) and cadmium telluride (CdTe) while using a minimum of materials to produce. The current challenges include reducing the manufacturing cost and faster transfer of R&D results to industrial production. Due to the fact that the CIGS manufacturing process is more complex and less standardized than for other types of cells, it is necessary to select appropriate process route and maintain the manufacturing as flexible as possible. A monolithically integrated CIGS thin film solar cell on 300 mm x 300 mm being research and developed at ARCI has promising features over the existing technologies.

Key Features

- Unique non-toxic two step, sputtering of precursor and atmospheric selenization process.
- Device configuration: Ag/AZO/ZnO/CdS/CIGS/Mo/Glass
- Tooled to make monolithically integrated CIGS thin film solar modules on 300 mm x 300 mm.
- Potential to make device on flexible substrates.



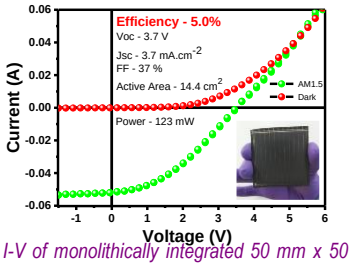
I-V of CIGS thin film solar cell on lab device

Potential Applications

- Building integrated photovoltaics (BIPV)
- Application for DC power appliance

Present status

- Maximum photo conversion efficiency of 8.2% on lab scale device
- Developed 50 x 50 mm monolithically integrated module with 5% efficiency.
- Demonstrated running 2V DC motor with propeller with the power output from mini module.
- Improvement in device performance on lab scale and module level is underway



I-V of monolithically integrated 50 mm x 50 mm module (Inset: Picture of in-house developed module)

Technology Readiness Level (TRL)

IPDI*	1	2	3	4	5	6	7	8	9	10
Activities	*Basic concepts and understanding of underlying scientific principles*	*Short listing possible applications*	*Research to prove technical feasibility for targeted application*	*Coupon level testing in stimulated conditions*	*Check repeatability/ consistency at coupon level*	*Prototype testing in real-life conditions*	*Check repeatability/ consistency at prototype level*	*Reassessing feasibility (IP, competition technology, commercial)*	*Initiate technology transfer*	*Support in stabilizing production*
Status										

IPDI : Intellectual Property Development Indices

Major patents/Publications

1. Process parameter impact on properties of sputtered large-area Mo bilayers for CIGS thin film solar cell applications, Amol C. Badgujar, Sanjay R. Dhage*, Shrikant V. Joshi, Thin Solid Films 589 (2015) 79–84

2. Transparent conducting Al:ZnO thin film on large area by efficient cylindrical rotating DC magnetron sputtering. Sanjay R. Dhage* and Amol C. Badgujar, *Journal of Alloys and Compounds* Vol 763, (2018) 504

3. Process parameter impact on selective laser ablation of bilayer Molybdenum thin films for CIGS solar cell applications, Amol C. Badgujar, Shrikant V. Joshi and Sanjay R. Dhage*, *Materials Focus* 7 (2018) 1-7

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