National Science Foundation
4201 Wilson Boulevard
Arlington, Virginia 22230

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Dear Colleague Letter - Exploratory Research on High-Efficiency, Monolithic, Two Dissimilar Materials (TDM) Photovoltaics

July 5th 2016

With this Dear Colleague letter (DCL), the Division of Electrical, Communications and Cyber Systems (ECCS) within Engineering Directorate of the National Science Foundation (NSF) announces its interest in receiving EArly-Concept Grants for Exploratory Research (EAGER) proposals aimed to enable solar cells with energy conversion efficiency reaching 30% and beyond.

BACKGROUND

In recent years, costs of solar photovoltaic energy production systems have decreased significantly. Since the launch of the SunShot initiative by the Department of Energy in 2011, cost of solar electricity has dropped by as much as 66% and the industry is approximately 70% of the way to meeting the SunShot 2020 goals. As such, large reductions in solar photovoltaic (PV) cell costs remain a major technological opportunity. Clearly, the reduction of solar cell costs can be achieved by increasing the energy conversion efficiency of solar cells and/or reducing the processing and material costs.

The emergence of new high bandgap solar cell material such as organic/inorganic hybrid perovskites holds the potential to achieve energy conversion efficiency beyond 30% with the possibility of low manufacturing costs. In recent years, the energy conversion efficiency of perovskite solar cells has risen to 22.1%1,2. However, significant challenges in materials and devices still exist to fully realize the potential of perovskites solar cells. These challenges include the stability of perovskites solar cell, the need for the replacement of Lead, cost-effective manufacturing processes, as well as the design and integration of devices.

Theoretical calculations predict that the efficiency of thin film solar cells made with two-junctions can exceed 30% when illuminated at one SUN3. The cell structure can be made with a single material system, such as in III-V materials solar cells, or with two dissimilar material systems. To date, 28% efficiency has been demonstrated using two-junction epitaxial III-V solar cells. However, high fabrication costs restrict their wide application. In contrast, a monolithic two-junction cell constructed with low-cost Two Dissimilar Materials (TDM) and connected in series in a two terminal device configuration presents a research opportunity that will enable high-efficiency cells while maintaining low fabrication costs. For example, the two-junction cells can be fabricated with a high bandgap top cell (material A) followed by a lower bandgap bottom cell (material B). An interconnecting layer between the two cells is required to allow for a series electrical connection. The bandgaps of the two materials need to be carefully selected to achieve the highest predicted efficiency3. To date a two-junction cell made of Two Dissimilar Materials (TDM) did not reach the theoretical expectation of a cell conversion efficiency beyond 30% (at one SUN).

The purpose of this DCL is to support innovative, exploratory research in materials, fabrication processes, device structure and integration of monolithic, TDM solar cells to achieve energy conversion efficiency beyond 30% at one SUN with cost-effective manufacturability.

VISION

This DCL seeks to support novel and exploratory fundamental research to enable major advances in

high-efficiency, monolithic, TDM solar cells including but not limited to perovskites material. Proposed research directions should be amenable to cost effective manufacturability. To achieve this goal, critical research challenges must be addressed.

These challenges include but not limited to:

- Explorations of Lead-free perovskites and other environmentally-benign materials with phase stability;
- Novel material design, for band gap tuning;
- Innovative material and device structures to build a monolithic solar cell with energy conversion efficiency beyond 30% in a two-junction architecture;
- Novel interconnect approaches with structural characterization to meet the current-matching requirement in the monolithic TDM solar cells;
- Low-cost film deposition and manufacturing processes to achieve high-efficiency monolithic TDM solar cells.

SUBMISSION

EAGER proposals responding to this Dear Colleague Letter must be submitted by **September 30th, 2016, 5:00 p.m.,** submitter's local time, via Fastlane or Grants.gov following NSF's Grant Proposal Guide (GPG) (Chapter II.D.2) instructions, and should clearly indicate the reason that the proposed work would be appropriate for EAGER support. **EAGER is a funding mechanism for supporting exploratory work in its early stages on untested, but potentially transformative, research ideas or approaches.** It may be considered especially "high risk, high payoff," for example, in the sense that it involves radically different approaches, applies new expertise, or engages novel disciplinary or interdisciplinary perspectives.

Please be sure that the title of the proposal in response to this DCL starts with "EAGER: TDM solar cells:" Proposals should include projects' long-term vision, specific goals to be accomplished during the course of the EAGER funding, and potential demonstrations to be developed. Investigators may be listed as PI or co-PI in no more than two submissions in response to this DCL. Collaborative proposals are strongly encouraged between science and engineering researchers. Joint review of proposals among complementary NSF programs will be pursued when appropriate.

For further information, please contact:
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Sincerely,

Grace Wang
Acting Assistant Director
Directorate for Engineering (ENG)

Reference:

1. NREL chart, www.nrel.gov/ncpv/images/efficiency_chart.jpg;
2. Xiong Li, Dongqin Bi, Chenyi Yi, Jean-David Décoppet, Jingshan Luo, Shaik Mohammed Zakeeruddin, Anders Hagfeldt, Michael Grätzel; Science 10.1126/science.aaf8060 (2016).
3. F. Meillaud, A. Shah, C. Droz, E. Vallat-Sauvain, C. Miazza; Solar Energy Materials & Solar Cells 90 (2006) 2952–2959.