Bay Area Photovoltaic Consortium

Photovoltaic Manufacturing Technology Research

Request for Proposals (RFP)

New High-Impact Concepts in Solar Photovoltaic (PV) Module Packaging

Issue Date: January 17, 2017
Responses Due: February 28, 2017

1. Solicitation Purpose

The purpose of this BAPVC RFP is to identify and support research aimed specifically at innovative *new concepts in solar photovoltaic (PV) module packaging* with the potential for decrease in cost and improvements in module performance and reliability. Selected proposals will be part of the DuraMat activity (described below) and provide investigators the unique opportunity to actively engage with DuraMat and the National Lab Capability Network that focus on solar module materials and designs to facilitate reductions of the levelized cost of energy (LCOE).

Successful proposals will be expected to demonstrate the potential to impact the deployment of low-cost, scalable and manufacturable packaging materials and technologies, and should include a clear path involving milestones for prototyping and demonstrating the concept within the period of the award.

DuraMat and this BAPVC RFP focus on opportunities beyond the cell level, including innovative packaging concepts that include materials and designs required for assembling, encapsulating and interconnecting cells as well as novel implementations of light management for improved quantum efficiency using light scattering, antireflective coatings, and interconnects are included.

New concepts in packaging are expected to be relevant for PV technologies that include, but are not limited to, Si, CdTe, CIGS, and emerging perovskites. In addition, new concepts for packaging c-Si heterojunction cells, ultra-thin Si cells, and module design with innovations in electrically conductive adhesives or materials with extremely low water vapor transport rates to achieve a degradation rate of less than 0.2% averaged well beyond 25 years are of interest.

The BAPVC will also consider proposals that *integrate new module functionality* as long as they meet the requirements for the potential for decrease in cost and improvements in module performance and reliability beyond 25 years. This includes:

- Approaches to ameliorate performance limits including, but not limited to, dependence on temperature, light intensity, spectral properties, or long-term degradation.
- Self-diagnosing modules incorporating sensors, or use the solar cells as sensors themselves, that diagnose performance, degradation, or need for cleaning.
- Integrated sensors or smart materials for intelligent modules that become part of smart infrastructure.
- Other novel demonstrable module concepts involving strategies for reliable flexible cell packaging, self-cleaning and the prevention of dust accumulation.

Proposals focused on the durability and degradation of mainstream module designs are discouraged for this RFP.

Proposals should include plans for a working prototype where improved module performance and reliability can be demonstrated. Reliability must be demonstrated with a credible scientific foundation and methodology including accelerated lifetime testing involving the synergistic effect of multiple stressors (e.g. temperature, mechanical stress, moisture, simulated solar radiation, etc).

2. DuraMat Goals

The DuraMat goals are to discover, develop, de-risk, and enable the commercialization of new materials and designs for PV modules with the potential for a levelized cost of energy (LCOE) <$0.03/kWh by bringing together the best of the national lab and university research infrastructure in collaboration with the PV and supply-chain industries. The vision is to double the rate at which companies can implement new materials in PV modules by coupling an Energy Materials Network (EMN) architecture (e.g. rapid discovery, characterization, and testing; theory, modeling, and simulation; data management and mining) with PV durability science (e.g. rapid durability testing, degradation mechanism identification, and lifetime prediction) and state-of-the-art analysis. Further information regarding the goals and operation of the DuraMat Consortium can be found at https://www.duramat.org.

3. Bay Area Photovoltaic Consortium (BAPVC)

BAPVC is a consortium led by Stanford University (SU) and University of California Berkeley (UCB) that is funded by the SunShot Initiative at the U.S. Department of Energy, industry members and the participating universities. Initial funding was received in 2011 as a part of the U.S. DOE's Photovoltaic Manufacturing Initiative (PVMI). In 2016, BAPVC received additional funding as a partner in the DuraMat Corsortium to leverage BAPVC's success in forming the premier platform in the U.S. for collaboration between leading academic researchers and U.S. manufacturers in the PV field. The consortium provides a vibrant forum for interaction among PV industry and academic experts to address the critical challenges in converting the U.S. leadership in PV R&D into leadership in PV manufacturing. The collective efforts of manufacturing and academic experts working together can spark great innovation. BAPVC conducts research and development in universities to produce technologies that industry members will use.

BAPVC conducts industry-relevant research and development that will impact high-volume PV manufacturing, produce a highly trained workforce, and speed up commercialization of cutting-edge PV technologies. BAPVC will develop and test innovative new materials, designs, and fabrication processes necessary to produce cost-effective PV modules in high volumes. The research aims to find technologies which can increase module power output and simultaneously reduce manufacturing cost. Success in research is measured by high quality publications and transfer of the technologies for development in industry.

BAPVC's industry members identify research priorities, inform the scope of RFPs, review and rank proposals, and monitor the progress of research. Industry members are the first to learn of inventions and will be in the best position, potentially in partnership with other member companies, to adopt and build on those inventions in their own laboratories and factories.

4. Project Duration, Funding, and Reporting

DuraMat, as part of the EMN, requires that each of these awarded projects include collaborative work with the DuraMat National Lab Capability Network. A description of the capability network and contact

information for each capability area leader can be located at https://www.duramat.org to develop these collaborations. Potential applicants should consider the following criteria when applying for funding through this solicitation:

1) Projects must engage the DuraMat National Lab Capability Network and clearly describe the specific technical interaction, including the relevant DuraMat Capability Area and why the interaction is needed in the proposed research.
2) University research projects are part of the DuraMat workforce development effort. As such, each award must fund at least one student or postdoc.
3) 22% cost share of total project costs is required.
4) Universities are strongly discouraged from buying equipment. All equipment purchases >$10K will be reviewed by BAPVC and DuraMat. Use of existing equipment within the Lab Capability Network is strongly encouraged.
5) Approximately $1.5M is available to support 4 – 5 proposed programs at a level of $175,000 per year. Projects will be funded for a period of performance of up to two years. The second year funding of the award is contingent upon satisfactory progress and the submission of an annual report 30 days prior to the end date of the first project period.
6) Contingent on continued support of the DuraMat program, it is anticipated that successful and impactful programs may be eligible for renewal at the end of the two year program.

5. Eligibility

BAPVC has created a strong community for collaboration between leading academic researchers and U.S. manufacturers in the PV field. This platform enables truly disruptive research – performed in the leading academic and national laboratories, under the guidance of US PV companies. This procurement intends to promote greater coordination among BAPVC projects, forming multi-investigator teams needed to achieve the aggressive goals set forth by the Industry Board. Investigators are strongly encouraged to seek and describe links and intended collaborations with existing BAPVC supported researchers along with their engagement with the DuraMat Lab Capability Network. Information about existing BAPVC research can be found at https://bapvc.stanford.edu.

Investigators from all domestic educational institutions are eligible to respond. Proposed budgets should include amounts requested for both the educational institution and lab capabilities use. Other entities including for-profit or nonprofit entities, FFRDCs, state or local government entities are not eligible to apply for funding.

6. Proposal Format

Proposals must adhere to a rigid format so that key information such as Objectives, Research Task Statements and Milestones can be quickly and simply located for ease of review. Proposals should not exceed five pages including the Summary Slide. Proposals will be entered into a standard template, included with this RFP as Attachment A. The length of individual topic-sections may be adjusted as needed to best present the project; however, in no case shall the total document exceed the five page limit. The document should be single spaced using the formatting of the templates and a font size no less than 11 points.

One page CV's for each of the Principal Investigators (PI's) and co-PI's may be included and do not count towards the five page limit.

A one page budget summary involving salient budget categories for the two year period should also be

included and does not count towards the five page limit. Proposed budget information does not require detailed cost development, but should highlight a non-binding estimate of the major features of the anticipated costs including labor, materials, equipment, travel, tuition and miscellaneous categories. Proposed budgets should include amounts requested for both the educational institution and lab capabilities use. Cost sharing is required at 22% of the total project costs as cash or in-kind support to enhance the productivity of the effort.

The single cover slide provides a very brief summary of the proposed project and should be delivered in the format shown in Attachment B. Use fonts no smaller than 12 points.

Other attachments or appendices to the proposal will not be considered.

7. Evaluation

Proposals submitted in response to this solicitation will be screened to ensure responsiveness to this RFP and for relevance to photovoltaic industry needs by BAPVC Management. Proposals passing this screening will be reviewed by technical experts from BAPVC member companies and peers. All reviewers will treat all proposal information and materials as confidential in accordance with the BAPVC Non-Disclosure Agreement (NDA) which can be viewed in the Industry Membership Agreement located in the BAPVC site https://bapvc.stanford.edu/.

Reviewers at all levels will be asked to focus specifically on the extent to which the Proposal addresses the following criteria:

1. Technical Impact:
    a. Extent of improvement on factors and scientific foundation for prototyping, developing and characterizing innovative *new module concepts for module packaging* with the potential for decreased cost and improvements in module efficiency, reliability and functionality.
    b. Probability of successfully achieving the project objectives and transferring the technology to industry within three to five years.
    c. Demonstration of meaningful impact in proposed quantitative deliverables at completion of the first year of research.
2. Technical Merit:
    a. Presentation of data, process descriptions and design factors for the proposed technology supporting the projected technical impact and demonstrating knowledge of the technology status and benchmarks.
    b. Plans for improved module reliability with credible scientific methodology including accelerated lifetime testing.
    c. Identification of technical risks or barriers to project success and plan for mitigation.
    d. Clarity of project plan including quantitative, achievable milestones towards a working prototype demonstrating the concept within the period of the award.

8. Proposal Selection

The BAPVC management will evaluate the findings from the industry and peer reviewers to identify competitive proposals. Management's recommendations to the Executive Board will combine this evaluation with factors impacting achievement of the objectives of this procurement in order to select projects for award. The BAPVC Executive Board will review the evaluation and approve the portfolio of proposals for award.

In the event that a project is selected for award, Stanford University will request a complete proposal and cost estimate to initiate negotiations for award. The educational institution must execute the BAPVC Membership Agreement for Research Members that describes plans for management of intellectual property and consortium operations. This agreement can be viewed in the BAPVC site https://bapvc.stanford.edu. Negotiation of the Sub-Award agreement will also require completion of U.S. Department of Energy forms including EERE-335 detailed budget justification form, justification of indirect rates, and NEPA EF-1.

9. Submission Procedure:

Questions should be addressed to Mia Sibug at miasibug@stanford.edu. Responses, if deemed appropriate, will be posted to the BAPVC web site with the question and distributed to all known potential respondents by e-mail.

Submit final proposals by e-mail to miasibug@stanford.edu with copy to npacheco@stanford.edu. Confirmation of receipt will be delivered by e-mail reply.

Attachments

A. Proposal Template

B. Summary Slide Template