PMC-EF2a
(2.06.02)

U.S. DEPARTMENT OF ENERGY
EERE PROJECT MANAGEMENT CENTER
NEPA DETERMINATION

RECIPIENT: Crystal Solar **STATE:** CA

PROJECT TITLE : Technology development for high efficiency solar cells and modules using thin (< 80 µm) single crystal silicon wafers produced by epitaxy; NREL Tracking No. 11-018 (Reference 09-030)

Funding Opportunity Announcement Number	Procurement Instrument Number	NEPA Control Number	CID Number
		NREL-11-018	GO10337

Based on my review of the information concerning the proposed action, as NEPA Compliance Officer (authorized under DOE Order 451.1A), I have made the following determination:

CX, EA, EIS APPENDIX AND NUMBER:
Description:

B3.6 Siting, construction (or modification), operation, and decommissioning of facilities for indoor bench-scale research projects and conventional laboratory operations (for example, preparation of chemical standards and sample analysis); small-scale research and development projects; and small-scale pilot projects (generally less than two years) conducted to verify a concept before demonstration actions. Construction (or modification) will be within or contiguous to an already developed area (where active utilities and currently used roads are readily accessible).

A9 Information gathering (including, but not limited to, literature surveys, inventories, audits), data analysis (including computer modeling), document preparation (such as conceptual design or feasibility studies, analytical energy supply and demand studies), and dissemination (including, but not limited to, document mailings, publication, and distribution; and classroom training and informational programs), but not including site characterization or environmental monitoring.

A11 Technical advice and planning assistance to international, national, state, and local organizations.

Rational for determination:

The Photovoltaic (PV) Technology Incubator project represents a significant component of the U.S. Department of Energy (DOE) business strategy of partnering with U.S. industry to accelerate the commercialization of photovoltaic system research and development (R&D) to meet aggressive cost and installed capacity goals. This specific partnership leverages technical capabilities and resources within the National Renewable Energy Lab (NREL) and other DOE laboratories/facilities to enhance and support areas of expertise within a small business in order to accelerate the development of the small business's technology. This early-stage assistance in crossing the technological barriers to commercialization also provides a better level of understanding and development on which the investment community can base decisions. Additionally, it will have multiple benefits for the country including reaching cost parity with baseload energy rates, increasing solar PV market share, boosting domestic solar manufacturing, and reducing greenhouse gas emissions.

The prime subcontractor, Crystal Solar, Inc., participated in the last round of PV Incubator projects, and a final NEPA review for those activities was signed on September 9, 2001 (NREL Tracking No. 09-030). Crystal Solar now hopes to participate in a Tier 2 Incubator subcontract, which is the focus of this NEPA review. For this proposed project, Crystal Solar would be the prime subcontractor, and the Georgia Institute of Technology would be a subcontractor to Crystal Solar for some laboratory activities, as described below. The proposed subcontract would be for work in the 18-month, Tier 2, PV Technology Incubator, in which two phases are proposed. The subcontractor would develop a novel technology for the fabrication, handling, processing and packaging of very thin, (< 80 microns thick, 125mm X 125mm) porous single crystal silicon wafers, solar cells and modules. To enable this, high throughput epitaxial reactors and associated process technology would be used. Thin wafer production would then be integrated with advanced device fabrication, cell to cell interconnect, and packaging to fabricate the completed PV module.

Phase I would include the following:
- Development and demonstration of the production of thin (< 80 µm) single crystal epitaxial films on porous silicon on 125 mm X 125 mm single crystal substrates
- The achievement of required materials properties (e.g. thickness and thickness uniformity, minority carrier lifetime
- Fabrication and testing of solar cells and modules utilizing the thin epitaxial silicon wafers.

It is expected that this would result in the demonstration and validation of epitaxial material quality and metrics that govern wafer costs, demonstration of device fabrication technology with thin silicon wafers, demonstration of cell efficiencies > 15% with < 80 µm thick cells bonded to glass and demonstration of mini module efficiencies > 13%.

Phase II would include the following:
- Continuing the development and demonstration of thin (< 80 µm) single crystal epitaxial films on porous silicon on 125 mm X 125 mm single crystal substrates

- Achievement of required materials properties (e.g. thickness and thickness uniformity, minority carrier lifetime)
- Fabrication and testing of solar cells and modules utilizing the thin epitaxial silicon wafers fabricated on and released from the porous silicon grown on a single crystal Si substrate (mini modules would be fabricated by laminating individual epitaxial silicon cells to thin glass and stringing and laminating these into mini modules – 260 mm x 260 mm in size).

Proposed activities at the existing Crystal Solar facility would be accomplished using existing laboratory equipment and employees. Proposed activities at Georgia Tech would use existing facilities and equipment utilized by employees and students that are committed to the solar program. The employees are full time research engineers and students are 99% of time PhD students. They both are well trained in safety in lab and handling chemicals. The Crystal Solar facility is located at 3050 Coronado Drive, Santa Clara, California 95054, within an industrial park (a site plan has been uploaded to this database). Georgia Tech is located on the Georgia Institute of Technology University campus in Atlanta, Georgia. Work is expected to occur from early May 2011 through late October 2012.

CRYSTAL SOLAR
Crystal Solar would utilize an existing properly engineered solar research and development laboratory in an industrial park. Work would be completed using industry standard methods and protocols, and in accordance with all federal, state, and local regulations. Chemicals and hazardous materials would be delivered by carrier truck, with containers sealed and double contained, and boxes strapped onto pallets. Only small quantities (i.e., one gallon containers or smaller) would be ordered at any one time, to facilitate ease of transportation and cleanup, in the unlikely event of a spill. All chemicals would be labeled, grouped, separated, and stored in accordance with local fire and safety guidelines, within "fire-safe" chemical-approved metal storage cabinets, located in designated areas. Gas cylinders would also be delivered by truck, then strapped onto special hand-truck dollies, and taken to designated secondary containment storage cabinets which are housed within a locked gas bunker, located in the rear exterior of the facility

For process use, chemicals would also be handled and transported internally in secondary containment. Where appropriate, small chemical-resistant squeeze bottles (labeled per OSHA HAZCOM) would be utilized for dispensing. A spreadsheet showing chemicals and amounts stored, frequency of use, storage location, and portions of laboratory where used, where and how received by the facility, as well as handling and general comments has been uploaded to this database. In addition, both a building site plan and facility floorplan have been uploaded to the PMC database. The site plan shows building exits, as well as locations of a cooling tower, chemical waste collection drums, acid waste neutralization, sulfuric acid/sodium hydroxide storage, cryogenic tanks and a scrubber. The laboratory floorplan shows locations of the gas cylinder bunker, wet chemical clean room, and metrology lab. Employees are required to go through periodic training in 1) Chemical Right to Know, 2) Chemical Safety and 3) Lab Safety. Employees are trained to follow proper PPE protocols whereby chemical-resistant gloves, safety glasses, face shields, gowns and full coverage aprons would be utilized as needed. Process stations would be properly labeled indicating chemical solutions used. Safety warnings and procedures for handling spills would also be posted. Exhaust fume hoods are installed over wet chemical benches, furnaces and ovens, the cabinets which house chemical waste drums are alarmed and monitored, and scrubbers are alarmed and monitored. Chemical appropriate absorbent pads are available in the event of chemical spills. Special heavy duty plastic garbage bags are used for collecting absorbent pads contaminated with spill content. Crystal Solar is also set up with a local external emergency response service to handle larger spill emergencies. Crystal Solar also has installed a sophisticated state of the art Life Safety Computer Monitoring System. In the event of a gas leak, the system automatically shuts off all gases at their sources. A large screen is mounted in the front lobby, with every sensor visually displayed. Any sensor triggered would be highlighted, with gas levels displayed, while sounding a strobe alarm throughout the facility. Any slight leak into a breathing zone area also notifies the fire department for immediate response. The system also monitors the scrubbers and acid waste neutralization system.

Crystal Solar holds applicable all permits necessary for this proposed project. They are a Small Quantity Generator (SQG) of hazardous waste with the assigned EPA identification number of CAD990832735. They file California Hazardous Material Business Plans (HMBP) and hazardous waste disposal reports with their local Certified Unified Program Agency (CUPA), Santa Clara Fire Department Hazardous Materials Division. They also have the appropriate fire code, flammable material, etc. permits with Santa Clara Fire Department Hazardous Materials Division. Solar Crystal has a local wastewater discharge permit (# SC-401B) and a stormwater permit (WDID # 2 430122335). They have an air permit exemption on file from Bay Area Air Quality Management District. This project would not require any modifications to existing permits and registrations, or acquisition of new permits. This proposed project would result minimal increases of hazardous waste generation, hazardous material utilization, and de minimis air emissions. All hazardous waste would be properly handled onsite and disposed of at offsite permitted facility via a licensed hazardous waste transporter. Hazardous gases would be exhausted in accordance with local, state and federal guidelines, directly through appropriate scrubbers. Uncontaminated wastewater would be sent through an acid waste neutralization station, prior to final discharge into the local city sewage system. Potentially contaminated wastewater would be pumped into 55-gallon poly enclosed drums, housed within specially designed secondary containment cabinets, and hauled away and disposed by a local professional licensed hauler.

GEORGIA TECH
Georgia Tech would utilize existing laboratories within an university campus. Work would be completed using industry standard methods and protocols, and in accordance with all federal, state, and local regulations. All chemicals would be stored in chemical-compatible containers and storage cabinets. Any flammable materials would be stored in a flammable-safe refrigerator. No containers over 5 gallons in size would be kept at the facility, and all container storage would include proper secondary containment. Gases such as ammonia and silane would be stored in self-contained gas cabinets equipped with gas leak sensors. Georgia Tech has a very robust safety protocols and training programs in place. All new employees must receive training on their rights under the Georgia Public Employees Hazardous Chemical and Protection and Right to Know (RTK) Law. Additionally, all employees who work with chemicals (labs, shops, custodial, landscaping, etc.) must receive refresher training annually. Georgia Tech's safety program includes numerous emergency planning and procedures related to indoor air quality, chemical spills, safe handling of nanomaterials, general safety (including ergonomics, electrical, first aid, injury reporting, AEDs, and PPE), shipping and handling of dangerous chemicals, as well as biological, physical, fire/life (including a fire safety handbook), and radiation safety. MSDSs, the NIOSH pocket guide, EPA fact sheets, and other safety-related documents are also available to employees. They have also deployed online training, the laboratory chemical management system, programs/policies/guidelines, inspection protocols, and contact information for responsible persons. The Georgia Tech Office of Environmental Health and Safety (EHS) is responsible for providing technical guidance, oversight, consultation, training and specialized services to assist the Institute community in meeting its public health, safety and environmental protection responsibilities.

Georgia Tech holds applicable all permits necessary for this proposed project. They are a RCRA Large Quantity Generator (LQG) of hazardous waste with the assigned EPA identification number of GAD003321619. Georgia Tech has a Title V major air source operating permit. Wastewater (acids and bases only) would pass through an acid neutralization tank and is then discharged to a combined sewer system. Therefore, an industrial wastewater permit is not required. This project would not require any modifications to existing permits and registrations, or acquisition of new permits. This proposed project would result in minimal increases of hazardous waste generation and hazardous material utilization. All hazardous waste would be properly handled onsite and disposed of at offsite permitted facility via a licensed hazardous waste transporter. All chemical processes would be done under a Georgia Tech EHS-certified fume hood which contains a scrubber for abatement. Alarms are in place above laboratory equipment where gases would be used, to detect gas leaks. Acids and bases would comprise the bulk of wastewater at the Georgia Tech lab. Any solvents that would potentially be used would be stored in appropriate containers after use, and picked up by the Georgia Tech Hazardous Materials Department for proper disposal.

Based on the information above, this proposed action would qualify for Categorical Exclusions A9, A11, and B3.6.

NEPA PROVISION
Note to Specialist :

EF2a prepared by Rob Smith on 05/09/2011

SIGNATURE OF THIS MEMORANDUM CONSTITUTES A RECORD OF THIS DECISION.

NEPA Compliance Officer Signature: Lori Plummer / Lori Plummer Date: 5/11/2011
NEPA Compliance Officer

FIELD OFFICE MANAGER DETERMINATION

☐ Field Office Manager review required

NCO REQUESTS THE FIELD OFFICE MANAGER REVIEW FOR THE FOLLOWING REASON:

☐ Proposed action fits within a categorical exclusion but involves a high profile or controversial issue that warrants Field Office Manager's attention.
☐ Proposed action falls within an EA or EIS category and therefore requires Field Office Manager's review and determination.

BASED ON MY REVIEW I CONCUR WITH THE DETERMINATION OF THE NCO :

Field Office Manager's Signature: _____ Date: _____
Field Office Manager