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To: Chris Scruton (CEC)
From: Steve Wiel
Subject: **Cool Roof Colored Materials**: Monthly Progress Report for December 2002
CC: Hashem Akbari, Paul Berdahl, Andre Desjarlais, Bill Miller, Ronnen Levinson

A summary of the status of Tasks and Deliverables as of December 31, 2002 is presented in Attachment 1.

HIGHLIGHTS

- We made significant theoretical and computational progress this month in our characterization of the optical properties of pigments.
- Negotiations are continuing with both Mike Evans Construction and the Sacramento Municipal Utility District (SMUD) for selection of potential monitoring sites.

Tasks

1.1 Attend Kick-Off Meeting
This Task is completed.

1.2 Describe Synergistic Projects
This Task is completed.

2.1 Establish the Project Advisory Committee (PAC)
This task is essentially completed. We have added two new members to the PAC (the updated list of PAC members is attached (Attachment 2):

i) Steven Harris, Certification Manager of the Quality Auditing Institute, representing the Cedar Shake and Shingle Bureau (CSSB).

ii) Aaron Backer, representing the DuPont Titanium Technologies.

2.2 Software Standardization
(No activity.)

2.3 PAC Meetings
(No activity.)

2.4 Development of Cool Colored Coatings

2.4.1 Identify and Characterize Pigments with High Solar Reflectance

We made significant theoretical and computational progress this month in our characterization of the optical properties of pigments. We revised the theory used to determine the Kubelka-Munk scattering and absorption coefficients to base the calculation on the one measurement of reflectance and one measurement of transmittance, rather than two measurements of reflectance, allowing us to better handle the common case of nearly-opaque films. We have also gained insight into the important phenomenon on reflection due to change in refractive index at a smooth interface, which can strongly influence paint-film reflectance. The theory has been written up as part of a journal paper being drafted, and the optical property calculations are in progress.

2.4.2 Develop a Computer Program for Optimal Design of Cool Coatings

The algorithms being developed under Task 2.4.1 will be used in this task.

2.4.3 Develop a Database of Cool-Colored Pigments

(No activity.)

2.5 Development of Prototype Cool-Colored Roofing Materials

2.5.1 Review of Roofing Materials Manufacturing Methods

No significant progress in December. The review of literature is progressing. We are also continuing the process of making arrangements with Elk, BASF, 3M, and ISP Minerals to visit a few industrial sites (manufacturing of roofing materials) in the vicinity of the Bay Area.

2.5.2 Design Innovative Methods for Application of Cool Coatings to Roofing Materials

The near-infrared (NIR) reflectance of a NIR-transparent paint film can be raised through use of a NIR-reflective undercoat. We have prepared samples of various NIR-reflective undercoats, including white paints with high concentrations of titanium dioxide, metal paints based on aluminum flakes, and mica-flake paints. We have found that even fairly thin layers of white paint can be made NIR reflective if the pigment concentration is high. The NIR reflectance of aluminum-flake paints (about 0.6) was significantly lower than that of aluminum foil (about 0.9), suggesting either that the binder or the flakes were more absorptive than expected. The NIR reflectance of the mica-flake paints was comparable to the aluminum-flake paints.

2.5.3 Accelerated Weathering Testing

(No activity.)

2.6 Field-Testing and Product Useful Life Testing

Final approval is still pending for use of the homes in the Sacramento subdivision being built by Evans Construction. Land use agreements were granted for setup of the exposure racks in seven sites across the state of California.

2.6.1 Building Energy-Use Measurements at California Demonstration Sites

Negotiations are continuing with both Mike Evans Construction and the Sacramento Municipal Utility District (SMUD). Evans Construction prefers minimal intrusions from data acquisition systems (DAS) and monitoring equipment. They want potential homebuyers to be enthusiastic about their new home, and not dissatisfied with unsightly DAS equipment. Therefore, we (ORNL) and SMUD are working toward a common data acquisition system for measuring wall, roof and HVAC performance.

SMUD is subsidizing Evans Construction in exchange for acquiring thermal performance data of insulated concrete foam (ICP) walls. We are interested in the roofs. Hence, we are discussing with SMUD the possibility of combining the two initiatives and working together on the performance of the building envelope.

2.6.2 Materials Testing at Weathering Farms in California

We (ORNL) have received approval from the California Department of Water Resources (DWR) to setup exposure racks in the vicinity of weather stations maintained by the California Irrigation Management Information System (CIMIS). A Memorandum of Understanding was forwarded to the DWR to define placement and maintenance requirements for the racks. The DWR requires that the racks not adversely affect the weather data. The DWR also wants their district DWR representatives to be informed of any site visits or maintenance. The DWR agreed to have their technicians check the exposure site as part of their monthly check of meteorological instruments. They will also support us with the retrieval and replacement of samples for scheduled measurements of reflectance and emittance.

The exposure racks will each be 5.5-ft high by 9-ft long. A rack will be divided into three sections having respective slopes of 2-, 4- and 8-in of rise for 12-in of run. Each section can hold two sub-assemblies that are easily removed from the rack for shipment to ORNL. All sub-assemblies will be designed to have 6 rows of samples with 34-in of usable space in each row. Sample size will be 4-in by 4-in, a size that LBNL's Perkin-Elmer Lambda 19 spectrophotometer and easily accommodate.

Our plan is to start field-testing of concrete tile, clay tile, and painted metal in the exposure racks in March 2003. The racks will have ample room when additional asphalt shingles are ready for testing. MCA will supply samples of clay tile, and Monier Life Tile will supply samples of cement tile. BASF will supply all the painted metal samples. We will conduct side-by-side testing of seven different painted metal colors with standard pigments and also with cool roof color pigments (CRCP) blended by BASF. A similar approach will be tried with the concrete tile; however, MCA manufacturers clay tile only with the CRCP.

2.6.3 Steep-slope Assembly Testing at ORNL

(No significant activity.)

2.6.4 Product Useful Life Testing

(No activity.)

2.7 Technology transfer and market plan

2.7.1 Technology Transfer

(No activity.)

2.7.2 Market Plan

(No activity.)

2.7.3 Title 24 Code Revisions

Pennington and Akbari discussed a few more minor modifications to the proposal for revision of Title 24 for cool roofs on existing non-residential low-sloped roofs.

Management Issues

- None

Attachment 1

Project Tasks and Schedules (*Approved on May 16, 2002*)

Task	Task Title and Deliverables	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 12/31/2002
1	**Preliminary Activities**					
1.1	Attend Kick Off Meeting *Deliverables:* • Written documentation of meeting agreements and all pertinent information (**Completed**) • Initial schedule for the Project Advisory Committee meetings (**Completed**) • Initial schedule for the Critical Project Reviews (**Completed**)	5/16/02	5/16/02	6/1/02	6/10/02	100%
1.2	Describe Synergistic Projects *Deliverables:* • A list of relevant on-going projects at LBNL and ORNL (**Completed**)	5/1/02	2/1/02	5/1/02	5/1/02	100%
1.3	Identify Required Permits	N/A		N/A		
1.4	Obtain Required Permits	N/A		N/A		
1.5	Prepare Production Readiness Plan	N/A		N/A		
2	**Technical Tasks**					
2.1	Establish the project advisory committee *Deliverables:* • Proposed Initial PAC Organization Membership List (**Completed**) • Final Initial PAC Organization Membership List • PAC Meeting Schedule (**Completed)** • Letters of Acceptance	6/1/02	5/17/02	9/1/02		98%
2.2	Software standardization *Deliverables:* • When applicable, all reports shall include additional file formats that will be necessary to transfer deliverables to the CEC • When applicable, all reports shall include lists of the computer platforms, operating systems and software required to review upcoming software deliverables	N/A		N/A		

Project Tasks and Schedules (contd.)

Task	Task Title and Deliverables	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 12/31/2002
2.3	PAC meetings *Deliverables:* • Draft PAC meeting agenda(s) with back-up materials for agenda itemsFinal PAC meeting agenda(s) with back-up materials for agenda items Schedule of Critical Project ReviewsDraft PAC Meeting Summaries • Final PAC Meeting Summaries	9/1/02	6/1/02	6/1/05		13% (1/6)
2.4	Development of cool colored coatings					
2.4.1	Identify and Characterize Pigments with High Solar Reflectance *Deliverables:* • Pigment Characterization Data Report	6/1/02	6/1/02	12/1/04		~ 17%
2.4.2	Develop a Computer Program for Optimal Design of Cool Coatings *Deliverables:* • Computer Program	11/1/03		12/1/04		
2.4.3	Develop a Database of Cool-Colored Pigments *Deliverables:* • Electronic-format Pigment Database	6/1/03		6/1/05		
2.5	Development of prototype cool-colored roofing materials					
2.5.1	Review of Roofing Materials Manufacturing Methods *Deliverables:* • Methods of Fabrication and Coloring Report	6/1/02	6/1/02	6/1/03		~ 40%
2.5.2	Design Innovative Methods for Application of Cool Coatings to Roofing Materials *Deliverables:* • Summary Coating Report • Prototype Performance Report	6/1/02	6/1/02	12/1/04		< 5%
2.5.3	Accelerated Weathering Testing *Deliverables:* • Accelerated Weathering Testing Report	11/1/02	10/1/02	6/1/05		< 3%

Project Tasks and Schedules (contd.)

Task	Task Title	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 12/31/2002
2.6	Field-testing and product useful life testing					
2.6.1	Building Energy-Use Measurements at California Demonstration Sites *Deliverables:* • Demonstration Site Test Plan • Test Site Report	6/1/02	9/1/02	10/1/05		5%
2.6.2	Materials Testing at Weathering Farms in California *Deliverables:* • Weathering Studies Report	6/1/02	10/1/02	10/1/05		10%
2.6.3	Steep-slope Assembly Testing at ORNL *Deliverables:* • Whole-Building Energy Model Validation Presentation at the Pacific Coast Builders ConferenceSteep Slope Assembly Test Report	6/1/02	10/1/02	10/1/05		~ 10%
2.6.4	Product Useful Life Testing *Deliverables:* • Solar Reflectance Test Report	5/1/04		6/1/05		
2.7	Technology transfer and market plan					
2.7.1	Technology Transfer *Deliverables:* • Publication of results in industry magazines and refereed journal articles • Participation in buildings products exhibition, such as the PCBC Brochure summarizing research results and characterizing the benefits of cool colored roofing materials	6/1/03	6/1/02	6/1/05		~ 3%
2.7.2	Market Plan *Deliverables:* • Market Plan(s)	5/1/05		6/1/05		
2.7.3	Title 24 Code Revisions *Deliverables:* • Document coordination with Cool Roofs Rating Council in monthly progress reports • Title 24 Database	6/1/02	5/16/02	6/1/05		~ 5%

Project Tasks and Schedules (contd.)

Task	Task Title	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 12/31/2002
VII	Critical Project Review(s) *Deliverables:* • Minutes of the CPR meeting					
XII (C)	Monthly Progress Reports *Deliverables:* • Monthly Progress Reports	6/1/02	6/1/02	6/1/05		19% (7/36)
XII (D)	Final Report *Deliverables:* • Final Report Outline • Final Report	3/1/05		10/1/05		
	Final Meeting *Deliverables:* • Minutes of the CPR meeting	10/15/05		10/31/05		

Attachment 2.
Update list of Project Advisory Committee members.

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