Development of Next Generation Cool Roofing Materials

("Next Generation Materials")

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Summary of Project

The goal of this project is to develop next-generation white and colored roofing products with aged solar reflectances superior to those from today's "cool" roofing products. White roofs that stay clean can save up to 70% more energy than soiled surfaces. The solar reflectances of cool white products will be enhanced by adding resistance to soiling through chemical and physical modifications. The solar reflectances of cool colored roofing products will be enhanced through coating processes that make more effective use of cool pigments, including spray coating of asphalt shingles and concrete tiles. Higher-performance cool colored roofs can save up to 50% more energy than today's generation of cool colored roofs.

Project Context and Relevance

The solar reflectance of an initially "cool" building envelope surface can be significantly reduced (up to 40%) by natural weathering processes, thus increasing the need for building conditioning energy. The proposed research, in concert with our ongoing efforts to develop accelerated soiling protocols, will facilitate the development of the next generation of envelope surface materials that are functionalized with de-soiling and anti-soiling additives. It will also improve the reflectances of the most common residential roofing products (shingles and concrete tiles). We expect this to spur demand for roof retrofits.

The Heat Island Group at Lawrence Berkeley National Lab has successfully collaborated with the pigment, coating and roofing industries to develop and advance to market cool colored roofing materials over the course of three projects from 2000 to present. For example, we are currently carrying out a project on "Advanced Surfaces" focusing on the development of accelerated soiling protocols. We have a wide array of equipment for the characterization and development of cool roofing materials. LBNL is a multidisciplinary laboratory with access to unique facilities and staffing with broad skills sets and a track record of carrying out research from basic science through commercialization.

Technical Approach

We will apply our understanding of roof weathering, soiling, and material science to develop and move toward market white roofing materials for low-sloped roofs—e.g., single-ply roofing membranes and elastomeric coatings—that retain high solar reflectance by shedding contaminants and resisting biological growth. Also, a new cool-colored technology for asphalt shingles and concrete tiles being developed by Lawrence Berkeley National Laboratory potentially offers about 50% more annual building energy savings than that available from the cool-colored shingles and tiles sold today. We will develop and move toward market cool-colored roofing materials that are significantly more reflective than those currently available. The prototype products created in these tasks will include white coatings, white single-ply membranes, cool-colored asphalt shingles, and cool-colored concrete tiles.

The first year of this project is divided into a **scoping phase** and an **implementation phase**. In the scoping phase, we will

- review current technologies with potential to increase the solar reflectance of roofing products;
- identify/establish industrial collaborations to carry out joint development of next-generation cool roof materials; and
- and develop a roadmap for the implementation phase.

In the implementation phase, we will follow the roadmap to

- develop and characterize cool white roofing products with improved solar reflectance;
- develop and characterize cool-colored roofing products with improved solar reflectance; and
- explore novel advanced technologies for further enhancing cool building envelope materials.

Some examples of potential next-generation products are shown in the figures below.

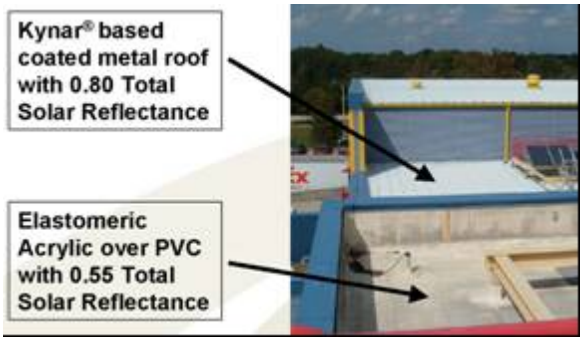

Figure 1. The solar reflectance of a white PVDF (Kynar®) coated metal low-sloped roof (0.80) is much higher than that of an adjacent white elastomeric low-sloped roof (0.55) after nine years of exposure in Florida.

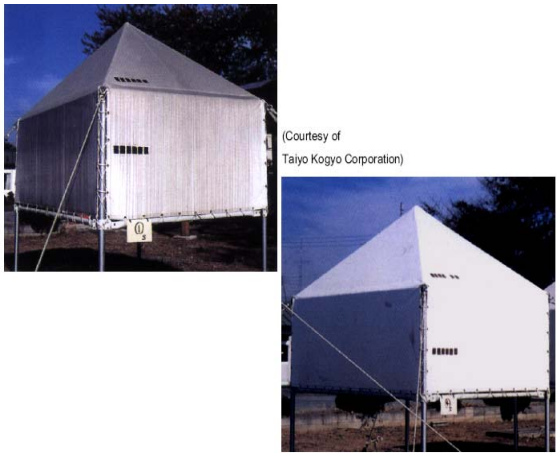

Figure 2. The incorporation of nano-sized TiO_2 in its surface keeps the photocatalytic tarpaulin tent material (right) cleaner than the adjacent conventional white tarpaulin tent material (left).

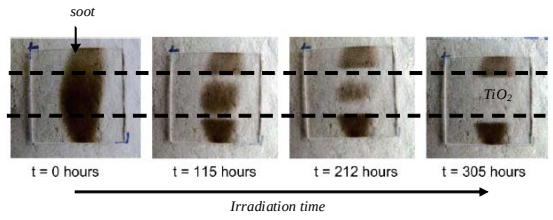

Figure 3. Self-cleaning effect through chemical processes: a layer of soot deposited over a TiO_2-coated glass is removed by photocatalytic oxidation under UV irradiation (Lee et al., 2004, J of Photochem Photobiol).

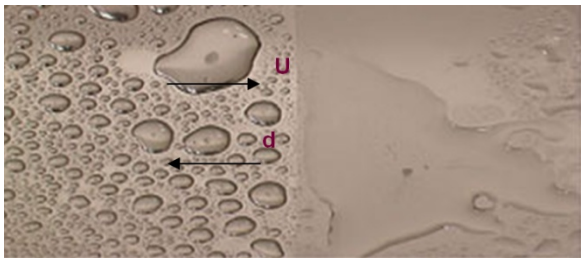

Figure 4. Self-cleaning effect through physical processes: water beads on a dark surface (left) but flows under UV irradiation (right), illustrating photoinduced hydrophilicity.