

# ROOF COATINGS: Cool Technology Is a Hot Topic

By **Cynthia Challenger**,  
CoatingsTech Contributing Writer

For many years it has been recognized that improving the reflectivity of roofing materials contributes to lower building temperatures and, as a result, reduced air conditioning requirements and lower energy costs. Over the last decade, in fact, many states and cities and utility companies in the U.S. implemented tax incentives and rebates, if not actual regulations, regarding the use of cool roofing. Various federal programs were also implemented. In May 2009, however, the spotlight was really focused this topic when, at the opening of the St. James' Palace Nobel Laureate Symposium in London, U.S. Energy Secretary Steven Chu spoke about how cool roofing (and lighter shades of pavement and sidewalks) could significantly reduce global warming.

Chu specifically mentioned that flat roofs should be coated white and sloped roofs painted with "cool-colored" paints that reflect light and heat, unlike conventional dark colored, coated surfaces. In combination with lighter shades for paved surfaces, more solar radiation would be reflected into space and air-conditioning needs would be reduced, leading to a significant reduction in carbon emissions. Importantly, he emphasized, this geo-engineering approach would be benign.

In his speech, Chu referenced the work of his colleague Art Rosenfeld, a physicist at Lawrence Berkeley National Laboratory and a member of the California Energy Commission. Rosenfeld and two coworkers in 2008 calculated that lightening the color of surfaces in 100 major cities around the world could save the equivalent of 44 billion tonnes of CO<sub>2</sub>.

Interest in cool roof coatings has dramatically increased since Chu made those remarks, with growing numbers of municipalities looking at this method as a means for potentially reducing energy consumption and improving their carbon footprint. California, for



Photo courtesy of Dow  
Construction Chemicals.

example, required highly reflective white roofs for flat-topped buildings beginning in 2005 and has since expanded its Title 24 Building Code requirements (effective summer 2010) to include cool roofs on residential buildings. Philadelphia has passed similar regulations. The city of Phoenix recently invested \$28,600 for cool roof coatings applied to a public housing complex.

It is important to note that there are other advantages beyond energy conservation. Reduction of the “heat island” effect in large cities can help decrease the smog and haze that is caused by high ozone levels, which in turn equates to better breathable air and less asthmatic conditions. The coatings also serve to protect the roof surface, reducing damage caused by ultraviolet radiation, acid rain, repeated expansion and contraction due to temperature fluctuation, and exposure to chemicals and water.

The current market size for all polymer-based roof coatings is estimated by The ChemQuest Group to be \$500–\$550 million. Of that amount, white cool roof coatings account for about \$170 million, with demand increasing at about 4% annually. The majority of these coatings are acrylic formulations (\$130 million, growing at ~5%/yr), with urethanes (4.5%/yr growth), silicones (1.5%/yr growth) and epoxies (1%/yr growth) accounting for the vast majority of the remainder. Sales of fluoropolymers, derivatives of polyvinylidene difluoride (PVDF), for re-roofing applications are quite small at about \$2 million (1.5%/yr growth). The market for factory applied colored coatings containing infrared (IR) reflective pigments that are used on high sloped roofs is in the range of \$100–\$150 million, according to ChemQuest.

The Dow Chemical Company and BASF are the leading resin suppliers for the field applied segment, where the strong growth rate for acrylics in particular is in large part driven by the political attention that cool roof coatings have received in the last year, particularly from the DOE and Secretary Chu, according to Dan Murad, president and CEO of ChemQuest. The federal Energy Star program also encourages use of cool roof coatings, with partner companies often offering products that allow homeowners to earn rebates, tax credits, and other incentives, says Mark Ryan, marketing manager with The Shepherd Color Company. Gaining LEED (Leadership in Energy and Environmental Design) credits with the U.S. Green Building Council program has become increasingly important as well. “LEED points can be earned for several reasons, including the use of non-VOC coatings, the energy-saving potential of the coating, and for the ability to recoat to extend the roof life rather than having to replace the roof, which requires removal of material

to a landfill,” observes Ed Karper, North America marketing manager with AkzoNobel.

Karper also notes that in general there has been a shift toward looking at the functioning of the entire roof assembly and not just the coating on the surface. “This approach considers the insulation and air circulation as well as the reflectivity of the coating, and systems are thus optimized to maximize performance of all aspects combined rather than considering their individual characteristics one at a time.” Along those same lines, John Linnell, roofing technology manager for the BaySystems business of Bayer MaterialScience, points to the growing trend to consider the SRI index, which considers both reflectivity and emissivity, rather than just reflectivity. “Acrylic coatings perform much better than aluminum coatings based on the SRI index, because aluminum coatings have very poor emissivity characteristics,” he comments.

Arkema and Solvay Solexis manufacture PVDF resins for the factory applied roofing market segment. Major IR pigment manufacturers include The Shepherd Color Company, BASF, and Ferro Performance Pigments, although most pigment suppliers now offer IR reflective pigments for this application. Today, approximately 70 different coatings producers and many of the roofing manufacturers in the U.S. have some type of cool roof coating in their product line.

The specific choice of coating type is dictated by several factors. The first major distinction lies with the use of white or colored coatings. White coatings are typically found on commercial buildings with flat or very low sloped roofs, where color is not a factor since the roof cannot be seen from street level. Higher-cost colored cool roof coatings are intended for use on steep sloped residential roofs where color of the roof is an important factor or where white coatings are not desired because of their aesthetics. White coatings are typically field applied, whereas colored formulations are often coil coatings that are factory applied to metal roofing.

For commercial buildings, choice of resin type is determined by the conditions experienced on the roof. “Where grease and chemical resistance are necessary, such as on the roofs of restaurants, cold storage facilities, and food processing plants, silicone or urethane coatings will be preferred,”

#### Typical Costs of White Cool Roof Coatings

Resin Type	Average Price/Gal
Acrylics	\$17
Urethanes	\$34
Silicones	\$27
Fluoropolymers	\$23
Epoxies	\$30

Source: The ChemQuest Group, Inc.



Photo courtesy of Dow Construction Chemicals.

explains Murad. Epoxies serve as base coats. PVDF coatings are typically factory applied to metal roofs and commercial metal siding. Acrylics, which are the least expensive option, are used everywhere else, including metal substrates.

Acrylic coatings wear off over time, while silicone and urethane are more durable. As long as the base coat remains intact, though, acrylics can be recoated. Acrylic coatings typically last for 5–10 years, but some companies do offer 20-year warranties. PVDF coatings offer long warranties and are considered very durable and chemically resistant. They are used extensively in the factory applied metal roofing market.

For many, cool roof coatings—no matter what the resin type—offer a means for extending the life of a roof at a fraction of the cost of replacing one. It is imperative, though, that the roof substrate still be in good condition. Applying a coating to a damaged roof will not solve the problem. In such cases, the roof will need to be repaired or replaced prior to applying the cool roof coating. Preparation of the surface is also critical. These coatings are exposed to extreme temperatures and weather conditions. Careful surface preparation is necessary to ensure maximum adhesion. As a result, many coating manufacturers require applicators to receive certification prior to being able to use their products.

While the basic technology of white cool roof coatings has remained the same in recent years, modifications to the acrylic backbone can provide improvements in performance. Dow Construction Chemicals is in the process of commercializing two new products that incorporate such changes. “We are focused on advancing the technology in order to improve performance and expand the applicability of cool roof coatings, both in terms of new geographies and new surfaces,” states Dow’s strategic marketing manager, Javier Banos.

Rhoplex™ EC3000 is designed for use in areas where high humidity and uncertain weather have previously kept people from using acrylic cool roof coatings due to concerns about proper curing. This new resin forms a tough skin over the top of the applied material in just 15–20 minutes, providing protection from rain and excess humidity while the

coating continues to cure. In addition to areas in the southern U.S., Dow is also finding customers in the northern parts of the country that see the technology as providing a way to extend the coating season further into the fall.

The company’s other new product, Rhoplex™ EC3100, is specifically designed for application on thermoplastic polyolefin (TPO) roofing. “Use of TPO, which is already white, has grown dramatically over the past 10 years and now accounts for about 20% of installed roofs,” Banos says. “These roofs are reaching the point where they need to be coated to extend their usefulness, but there is a problem with adhesion of traditional roof coatings on this unique surface.” Dow has thus developed a modified acrylic that addresses the adhesion issue specifically for TPO, and expects that demand for the new coating will grow significantly in the coming years.

Other areas of research for the company include improving water and dirt pickup resistance. “Our resins have always performed well in these areas, but there is room for improvement,” Banos states. “Elastomers do suffer from dirt pickup. We are hoping to attenuate that characteristic as much as possible by modifying the nature of the acrylic backbone.” Dirt pickup properties will be particularly important as interest in cool roof coatings increases in emerging economies, where air pollution presents a real challenge for the use of cool roof coatings based on a white surface. Water resistance can always be improved given the conditions under which these resins must perform.

To encourage the use of white roof coatings in non-traditional applications, Dow recently organized a contest for blocks of row houses within the city of Philadelphia. While these are residential buildings, the roofs are flat or low-sloped and are tightly packed together, making them ideal candidates for cool roof technology. Neighborhoods



This residence contains white roof coatings which is representative of the refurbished homes participating in the Philadelphia “Coolest Block” contest. Photo courtesy of Dow Chemical Company.

were required to write an essay about their block and to get all homeowners to sign it. The winning block received roofing insulation and cool roof coating solutions from Dow Building Solutions.

Meanwhile, BaySystems has been involved in projects with solar collector manufacturer Solyndra, which places its collectors on rooftops. "Solyndra combines installation of the collectors along with cool roof coatings to increase the reflectivity of the roof and thus the effectiveness of the collectors," explains Linnell. BaySystems acrylic coatings were selected, according to Linnell, because they provide the most reflectivity and stay whitest the longest. The company, in many of its formulations, now uses a combination of biocide and mildewcide to help keep biocontamination to a minimum.

Aqueous PVDF systems introduced by Arkema in 2006 have received growing attention. The coatings are a mixture of PVDF and acrylics and are designed for field application onto metal roofs that need to be re-coated. These coatings have been shown to exhibit excellent durability and dirt pickup resistance.

In the case of colored coatings for metal roofs, two types of resins have been found to be most effective. Coatings are formulated with either a blend of polyvinylidene difluoride and acrylic resins (70:30 ratio) or silicon-modified polyester resins (SMP). The choice of resin is dictated by the need for strong adhesions and long-term durability.

Specially designed infrared-reflective pigments are available in shades ranging from black to brown to blue and green, tans and yellows, and even turquoise. Blends of these pigments can be combined to provide most all of the color shades required for the roofing market while maintaining a higher reflectivity than could be achieved years ago, explains Gil Burkhart, North American sales and marketing manager with Ferro Pigments. "We are continuously exploring ways to increase the reflectivity of these pigments and expand the range of available colors with higher reflectivities."

Within the last few years, there has been a focus on improving the ease of use of IR pigments. Color matching is also very important with IR pigments for cool roof coatings. Not only must the right color be achieved, but it must be optimized for reflectivity and durability," Mark Ryan comments. "The blending of the pigments must be done very carefully in order to meet all of the performance expectations."

Shepherd Color, for instance, introduced easily dispersed stir-in IR pigments that eliminate the need for the user to learn how to optimize the dispersion and make it possible to repeatedly obtain the desired performance batch after batch. "We have found that the pre-dispersed pigments, notably our Dynamix version of our Arctic IR Black, have received growing attention recently, particularly from coil coaters of metal roofing," notes Ryan.

Opportunities for growth of the IR pigments market are not limited to colored coatings. They

are also coming from some unexpected segments of the roofing industry. Roof shingle manufacturers, for example, are pre-coating the granules used to make their shingles with colored cool-roof coat-

---

**"Today, approximately 70 different coatings producers and many of the roofing manufacturers in the U.S. have some type of cool roof coating in their product line."**

---

ings, according to Ryan. The granules are coated with silicate type coatings manufactured by the shingle producers. "This use of infrared reflective pigments has the potential for growth and expands the applicability of these products to different types of cool roof systems."

At least one new entrant into the roof coating market is hoping to get a share of the cool coatings market. United Environment & Energy is developing a "smart" roof coating that can respond to changes in temperature. According to vice president Ben Wen, the coating is based on a virtually odorless polymer prepared from waste cooking oil, and can be prepared in any color and applied to most surfaces. It includes a proprietary thermosensitive additive that reflects light at higher temperatures and transmits light at lower temperatures.

Initial tests have been positive. Asphalt shingles coated with the new material have been found to reduce the roof temperature in warm weather and increase the roof temperature in cooler weather as compared to a conventional cool roof. Tests of the coatings weatherability and other performance characteristics are ongoing at the company. Wen expects UEE will have a commercial product available in three years or less.

With all of the interest in cool roof coatings generated by the comments of Energy Secretary Chu, perhaps it should not be surprising that new companies and new sectors of the roofing industry are looking for ways to be cool. And while cool roof coating manufacturers continue to help buildings stay cooler, they will happily be dealing with a very hot market. **CT**