or more than 30 years, elastomeric acrylic roof coatings have been a popular choice for the maintenance of low-slope roofing systems. Coatings protect the main roof substrate from degradation by the elements and prolong the life of the existing roof, thus saving a building owner the roof replacement costs.

Elastomeric acrylic roof coatings adhere to virtually all existing roofing substrates and deliver flexibility at low temperatures, UV and dirt pickup resistance, water resistance and the ability to be applied in thick films without mud cracking.

Acrylic roof coatings can be formulated to be white and solar-reflective, effectively turning an existing roof into a cool roof as well. Besides saving energy and reducing building cooling requirements, cool roof coatings can help to extend the life of the roof by lowering the average temperature of both the substrate and the roof assembly.

Getting Down to Basics
At the core of the elastomeric acrylic roof coating is the acrylic latex polymer, a binder that holds all the ingredients of
the coating together. An acrylic latex polymer is a stable dispersion of polymer particles in water. Acrylic polymer chemistry is versatile and has been evolving over the last 30 years, thanks to a large body of technical research in the field conducted in both academia and industry.1,2,3

One of the key advantages of acrylic chemistry is its range of polymer building blocks, or monomers. These monomers, which vary in a host of key properties, can be combined in numerous combinations and quantities to create latex polymers with properties tailored to specific roofing applications.

Process variables also play a critical role in final properties — how the monomers are combined is as important as the identities and quantities of the monomers that are being combined.

Another example of the versatility of acrylic chemistry is illustrated in Figure 1, which shows a variety of morphologies created with acrylic polymers. These morphologies offer additional approaches to creating unique properties in products formulated with acrylic polymers. They allow these polymers to be used in many products including architectural coatings, adhesives, sealants, cement modifiers and more. Cross-pollination of technology advances from numerous applications and industries benefits all users of these polymers.

The combination of polymer backbone, polymerization process and morphology provide many levers for optimizing acrylic latex performance for the intended application. Key mechanical properties for roof coatings, for example, include low-temperature flexibility, tensile strength, elongation and tear-resistance.

Figure 2 shows how these properties can be dialed in for Polymer A, an all-purpose binder suitable for both cold and warm temperature climates; Polymer B, a hail-resistant binder with enhanced toughness; and Polymer C, a binder targeted for more rigid substrates and asphalt bleed resistance.

Even though the acrylic latex technology has been used in roof coatings for many years, recent improvements have occurred in water resistance, dirt pickup resistance, early rain resistance and adhesion. Here, we highlight some of the innovations expected to make their way into elastomeric acrylic roof coatings within the next few years.

Water Resistance

Resistance to water ponding on the roof may be the single most important performance feature needing improvement for elastomeric acrylic roof coatings. While properly designed flat roofs should not have water ponding areas — areas where water stays for more than 48 hours — the truth is, many low-slope roofs have areas that retain water far longer than 48 hours. These are the areas where, with time, roof coatings fail.

After prolonged submergence in water, roof coatings change internally and lose adhesion to the underlying roofing substrate. Adhesion loss leads to the formation of blisters, which break over time and expose the substrate.

Water ponding areas also tend to accumulate dirt and soot, which darkens white roofs. The loss of reflectivity leads to even
The faster degradation of the roof coating since it absorbs more solar radiation.

To minimize the harmful effects of prolonged water exposure, polymers for acrylic roof coatings are designed for an optimal balance of hydrophobicity and tensile properties.

In addition, acrylic roof coatings employ the chemical mechanism called cross-linking. Cross-linking is the process of connecting acrylic polymer chains so that the resulting network is even tighter and tougher and can keep the water from penetrating into the coating. Conventional acrylic roof coating formulations employ zinc oxide as a cross-linker — the zinc oxide connects to the acids on neighboring polymer chains, creating a tightly knit polymer network in the coating with reduced water absorption, increased tensile strength and improved resistance to water.

The most advanced elastomeric acrylic roof coatings on the market today, with zinc oxide cross-linking, achieve seven-day water absorption in the range of 8 percent. However, many exhibit higher water absorption, up to 20 percent. The acrylic polymers of the future will improve on these performances by employing alternate cross-linking mechanisms, both organic and inorganic, incorporated during the polymerization of the latex.

Cross-linked polymers under development exhibit water absorption values in the 4-5 percent range, as shown in Figure 3. These new acrylic waterborne polymers not only have excellent mechanical properties, superb adhesion and outstanding blister-resistance in water ponding areas, but they retain all the advantages of waterborne technology: low VOC, ease of cleanup, ease of formulation and ease of application.

Dirt Pickup Resistance

As the first level of defense against the elements, roof coatings weather and get dirty with time. Dirt pickup is often

![Fig. 1: Particle morphologies achievable with waterborne acrylic chemistry.](image1)

![Fig. 2: Key polymer mechanical properties (strength, elongation, low temperature flexibility and tear-resistance) tailored for specific roof coating applications.](image2)
measured indirectly as a decrease in the film’s ability to reflect incoming solar radiation. A white roof coating that has high solar reflectivity when first installed may see a considerable decrease in reflectivity after several years’ exposure.

Regulations increasingly require that aged roofs maintain a minimum level of solar reflectivity, even after several years of service. For example, California Title 24 not only requires that a new flat roof have an initial solar reflectance of ≥75 percent but also requires that it maintains a minimum of 63 percent solar reflectance after three years of aging.

Future regulations for flat-roof solar reflectivity will likely be even more rigorous, requiring that roofs stay reflective longer and at higher levels.

Significant research in roof coatings and polymers for roof coatings has been devoted to finding ways to improve dirt pickup resistance. In fact, technologies already exist that allow roof coatings to maintain their solar reflectivity at a 70 percent level after five years of aging.

In one of these approaches, polymer bead technology is incorporated into an acrylic roof coating to improve long-term solar reflectivity. In the near future, this and other technologies are set to be optimized and

*Fig. 3: Water absorption after a seven-day soak at room temperature for the (a) best-in-class conventional acrylics and (b) a new class of acrylic coming to market in the near future.*
incorporated into the next generation of acrylic roof coatings without a significant increase in cost.

**Early Rain Resistance**

Waterborne roof coatings cure by water evaporation. As water leaves the coating, the latex particles come closer together and coalesce, forming a continuous solid film. Depending on ambient humidity and temperature conditions, this curing process may take 24 hours or longer.

Rain during this period can disrupt film formation and wash the coating away. Roof coating applicators often need to schedule their jobs even if there is a chance of rain soon after the coating is applied. New technologies, borrowed from the field of traffic paints, have been optimized for acrylic roof coatings. These technologies allow roof coatings to withstand early rain, even though the curing of the film is not complete.

The image above shows three acrylic roof coating films on aluminum substrates. The film on the left is the control. The film in the middle represents the first-generation improvement in early rain resistance. The film on the far right has the latest early-rain resistance technology built into the acrylic polymer. The films were cured for 20 minutes and then subjected to 60 minutes of hard continuous shower. The film on the right, with the optimized early rain resistance, is intact, even though the curing inside the film is not complete.

**Adhesion to Weathered TPO**

Adhesion to low-surface-energy substrates, such as weathered thermoplastic polyolefin (TPO), will be a necessary property of future roof coatings. Over the past 15 years, TPO singly-ply membranes have become the most popular choice for new flat roofing in the U.S. According to the National Roofing Contractors Association (NRCA), about 36 percent of new low-slope roofs installed in the U.S. are TPO roofs. As these roofs age, the need to coat them to prolong their useful lives will become critical.

Having low surface energy, TPO membranes, even aged, are challenging substrates to adhere to for any roof coating. However, recent advances in acrylic technology have resulted in the development of acrylic polymers for roof coatings with excellent adhesion to weathered TPO substrates. There are products on the market today that not only provide good adhesion to TPO but also maintain a remarkable balance of other properties, such as good mechanical properties and excellent dirt pickup resistance.

The photo on page 25 shows an example of a new acrylic technology that provides notable adhesion to weathered TPO. In this example, a coating with enhanced TPO adhesion was applied to a TPO membrane that was aged for four years before the test was performed. Researchers cured the prepared panel for two weeks, then placed it underwater for seven days. The new technology showed no blisters over the TPO surface.

**What the Future Brings**

The versatility of waterborne acrylic technology allows it to meet the changing demands of the roof coating industry. New technical approaches being incorporated into acrylic polymer solutions point to the future of waterborne acrylic elastomeric roof coatings. Significant improvements have been made to water resistance, early rain resistance, dirt pickup resistance and adhesion.
Additional efforts are underway to further improve these properties and to improve adhesion to low-energy substrates such as silicones, new asphalt and PVDF. Future approaches will continue to push the envelope of roof coating performance. Roof coatings solutions of the future may well combine acrylic technology with other innovative technologies to create products with an even more remarkable set of properties.

Notes

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Vicki Demarest is a roofing R&D leader, Arthur Kravchenko is a strategic marketing manager, and George Daisey is a research scientist in the Dow Construction Chemicals business unit at The Dow Chemical Co. Dow Construction Chemicals is a member of the Roof Coatings Manufacturers Association (RCMA), the national trade association representing manufacturers of asphaltic and solar reflective roof coatings and industry suppliers. The RCMA and the Reflective Roof Coatings Institute (RRCI) have merged into one industry association that continues to advance the national and international market for roof coatings. D+D