



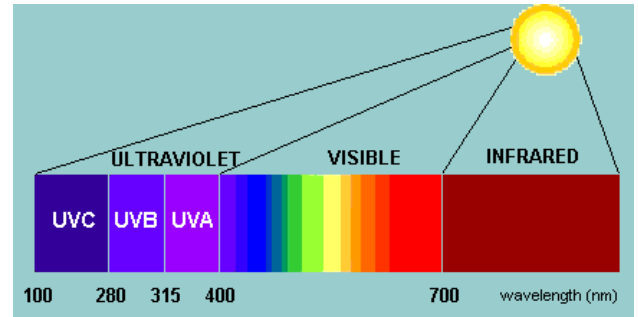
# Kalcor University

## Heat Reflective Coatings

Or...more than meets the eyes.



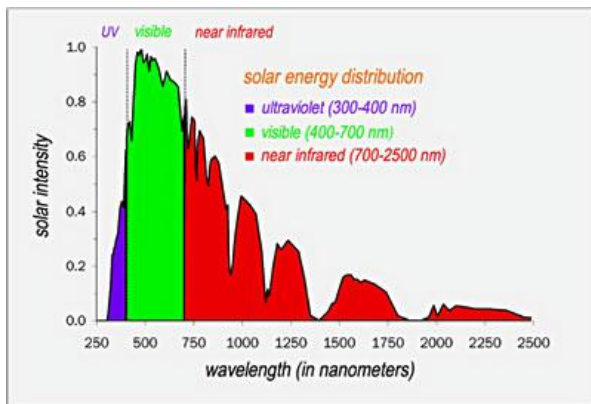
A prism separates visible light into its spectral components. For visible parts of the spectrum you might even know the popular R-O-Y-G-B-I-V mnemonic for remembering the colors of the spectrum, with red being the longest wavelength and violet the shortest.



Of course, the spectrum doesn't really stop with red or violet – our eyes just can't see the ultra-violet wavelengths at one end or into the infra-red at the other. Just as a dog hears

frequencies we cannot, there are wavelengths beyond the ability of our eyes to see them. Typically, the upper end of human eyesight is around 700 nanometers. But we are well aware of the effects of longer wavelengths above this when we warm ourselves from the sun's longer infrared (IR) rays.

An object's color is determined by which parts of the electromagnetic spectrum the object reflects and



which wavelengths it absorbs. Colors are made up of a mixture of these wavelengths. For example, yellow light is made up of 50% green light and 50% blue light. Something that appears to be yellow, therefore, is absorbing red light, and reflecting yellow and blue light. Your eye sees the reflected light, so the object appears to be green.

An object that appears to be white reflects all light, while something that appears to be black absorbs all light. But what about the absorption of the wavelengths

we cannot see, like the infra-red wavelengths in sunlight? We cannot see these wavelengths with our eyes, but they behave in a similar fashion. Some materials absorb them and some reflect them.

Coating additives have differing IR absorption properties, including the pigments that give a paint its color. It's important to note that just because two pigments reflect visible light very similarly does not mean that they absorb IR in the same manner.

This means that while two coatings could look the same to our eyes, they may look quite differently with respect to how they absorb unseen IR wavelengths (heat).

To speak quantitatively about these properties, we commonly refer to the Total Solar Reflectance (TSR) of a pigment or coating. Total solar reflectance is a measure of the amount of incident solar energy that is reflected from a given surface. Mathematically, it is a proportion that compares the sum total (or integration) of the percent reflectance times the solar irradiance divided by the sum total of the solar irradiance over the entire 280 to 2500 nanometer wavelength range:

$$\%TSR = \frac{\int (\% R \cdot Id\lambda)}{\int Id\lambda} \cdot 100 \quad (1)$$

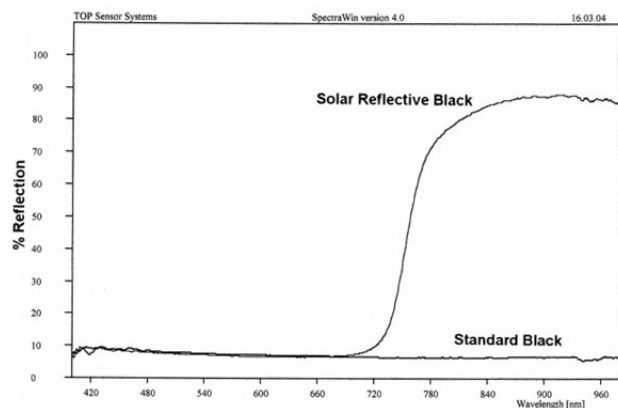
where R = percent reflectance  
 I = solar irradiance  
 dλ = the wavelength interval of integration

White coatings typically exhibit a TSR of 75% or greater. By definition, a white coating, with a TSR of 75% will absorb 25% of the incident energy. A conventional black coating, incorporating carbon black pigments, may have a TSR low as 3% and, therefore, will absorb 97% of the incident solar energy.

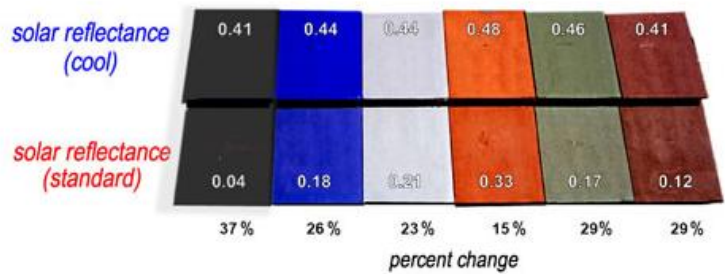
Total solar reflectance can be computed from data obtained from a UV-VIS-NIR spectrophotometer though a good approximation can be made with a Solar Spectral Reflectometer (SSR) (like that available from Devices and Services Company). ASTM C 1549 utilizes the SSR in determining the solar reflectance of substrates.

Conventional pigments which absorb IR have been replaced in solar reflective applications with pigments called mixed metal oxides (MMO) or complex inorganic colored pigments (CICP). These new formulations provide long lasting color, and the inorganic ceramic nature of the pigments offer excellent resistance to high temperatures, chemicals, acids, bases, weathering and environmental pollutants.

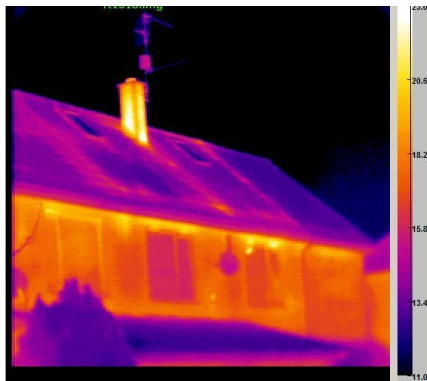
Very few colors are created from single-pigment dispersions. Usually in order to match a specific color, several pigments must be blended and care must be exercised when more than one pigment is mixed together to create a complex color. Most any IR reflective pigment, when combined with white, will provide a higher total solar reflectance than the pigment alone. A mixture of two pigments with



different absorption profiles will frequently have a lower reflectance than the pigments have individually. For example, while a blue IR reflective pigment and a black IR reflective pigment might each have a TSR near 25%-30%, when combined they will have a lower TSR than a weighted average of the individual pigments.



There are numerous benefits to solar reflective coatings. Much attention has been focused on the consumer benefits of the coolroof or cool building envelope. IR reflectance means a more comfortable home, with significantly lower energy costs for cooling. In some states, particularly in the south and west, solar reflective coatings have become commonplace and organizations are now specifying coolroof technology for new construction.



But the idea of coatings that keep things cooler is expanding into new applications for outdoor electronics and mechanical enclosures, and even for automobiles. The California Environmental Protection Agencies Air Resources Board is studying ways to reduce CO2 greenhouse gases from being released and is studying the potential impact of high-TSR coatings for reducing pollution and saving energy.

Aside from those features related to a product's use, IR reflective coatings also provide benefits to the coating and part itself. By reflecting damaging IR rays, the coating lifetime is extended, with less fading and deterioration. The substrate also stays cooler so plastics coated with solar reflective coatings last longer and show less warping, expansion and other heat related damage.

#### Recap: Some Benefits of Heat Reflective Coatings

1. Less Heat transfer to buildings
2. Lower energy use and smaller carbon footprint
3. Longer substrate lifetime due to reduced degradation
4. Aesthetically pleasing color substitute
5. Cooler-to-the-touch for added user comfort