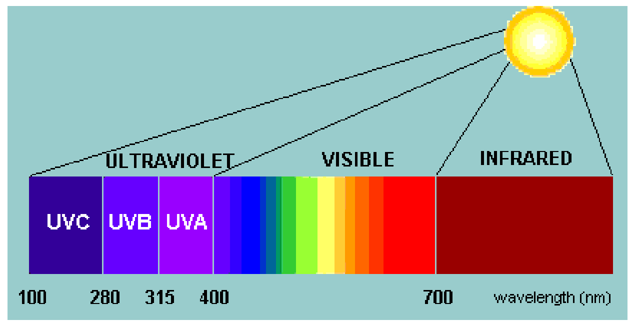
Kalcor University

Heat Reflective Coatings

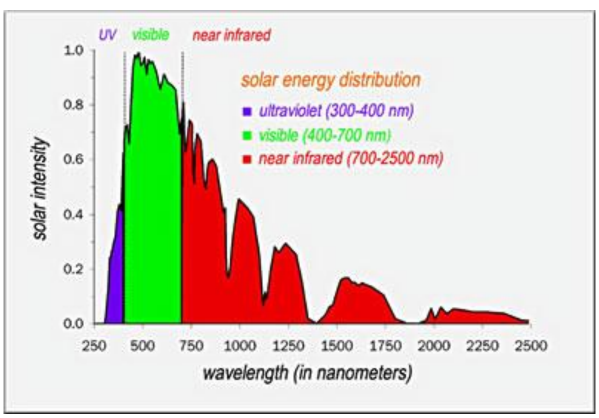
Or…more than meets the eyes.

A prism seperates 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. But 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 as we warm ourselves from the sun's longer infrared, (IR) rays.

An objects color is determined by which parts of the electromagnetic spectrum an object relfects and which wavelengths it absorbs. Colors are made up of a mixture of a these wavelengths. Yellow light, for example, 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, something that appears to be black absorbs all light. But what about the absorbtion 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 absorbtion properties, including the pigments that give paint its color. It's important to note that just because two pigments may 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 ay look quite differently with respect to how they absorb unseen IR wavelengths (heat).

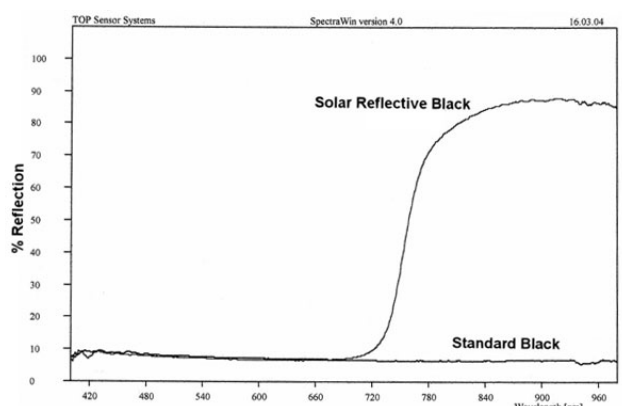
To speak quantitatively about these properties, we commonly refer to the Total Solar Reflectance (TSR) of a pigment, or coating. Total solar reflectance is a measure of the amount of incident solar energy reflected from a given surface. Mathematically, it is a percentage proportion that compares the sum total (or integrtion) 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:

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

where R = percent reflectance
I = solar irradiance
$d\lambda$ = the wavelength interval of integration

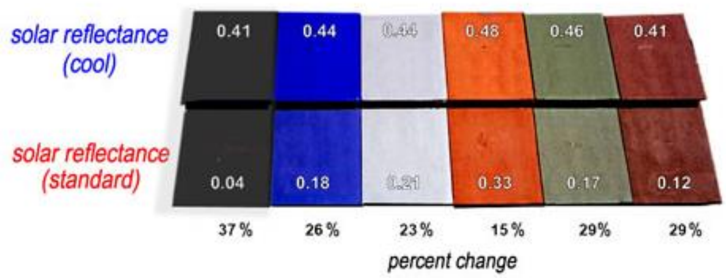
White coatings typically exhibit a TSR of 75% or greater. A white coating, at a TSR of 75%, by definition will absorb 25% of the incident energy. A conventional black coating, based on carbon black pigmentation, may have a TSR low as 3% and, therefore, will absorb 97% of the incident solar energy.

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. (ASTM C 1549 utilizes the SSR in determining the solar reflectance of substrates.)

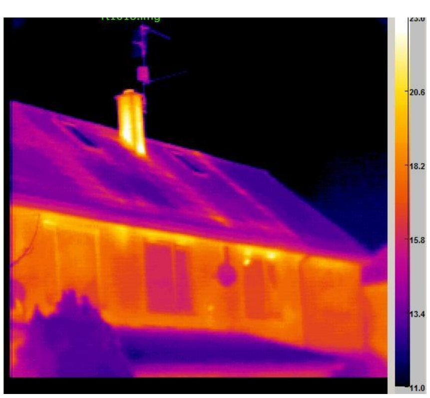


Conventional pigments which absorb IR have been replaced in solar reflective applications with pigments called mixed metal oxides (MMO) or complex inorganic colored pigments (CICP). These new formulations provide long lasting color, and the inorganic ceramic nature of the pigments offer excellent resistance 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 excercised 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 and a black pigment might have about 25-30% TSR, 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 consumerbenefits of the cool-roof or cool building envelope. IR reflectance means a more comfortable home, with signficantly lower energy costs for cooling. In some states, particularly in the south and west solar reflective coatings have become commonplace and organizations



But the idea of coatings that keep things cooler is expandinginto 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 relased and is studying the potential impact of high TSR coar paints for reducing pollution and saving energy.

Aside from those features related to a products 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.

Some Benefits of IR Reflective Coatings

- Less heat to transfer into buildings.
- Reductions in air pollution due to lower energy usage and power plant emissions
- Longer life-cycle due to lower polymer degradation and thermal expansion
- Aesthetically pleasing color substitute
- Cooler to the touch for better ergonomics and user comfort