Emissivity and Infrared Thermography

When using an Infrared Thermographic camera, there are two sources of infrared energy that the camera will detect. They are emitted IR radiation from the surface of objects being inspected, and reflected IR radiation from other heat sources. Emission and reflection are inversely proportional—the better a material is at emitting IR then worse it is at reflecting, and vice versa.

The ability of a surface to emit heat by infrared radiation is called the emissivity. Emissivity values range between zero for a very good reflector, and one for a very good emitter. This is where the "Low-e" of high efficiency windows comes from. They have a Low-Emissivity coating on the glass that changes the way it performs.

Most non-metals have quite a high emissivity value, so thermal imaging is representative of their true temperatures—this includes drywall, wood, and carpet. Shiny metals, on the other hand, have low emissivities and high reflectivities. These materials primarily display objects they are reflecting and make measurements difficult—this includes mirrors, which can reflect back the IR signature of the thermographer themselves!

What does this mean for IR imaging in a home? An object with low emissivity can appear to be the same temperature as the rest of the room, since it is reflecting back the thermal radiation from everything around it—when in fact, the object may have a very high or very low temperature hidden by its reflective qualities. In energy auditing, this is particularly an issue with windows and shiny metal. Some IR cameras allow you to compensate for emissivity when doing a scan by selecting either the material itself or its properties, which can go a long way toward getting a more accurate reading.

When you are walking through a house doing an energy audit, it helps to keep emissivity and reflectivity in mind before you make conclusions about a home's performance. Was an area actually under-performing, or was it reflecting IR radiation off another surface? In the images above we see two cups that are the same temperature—they both contain boiling hot water and the metal cup on the right, while low in emissivity is still highly conductive when it comes to heat—but the thermograph of them reads the plastic cup much hotter while the only portion of the metal cup that reads hot is reflecting the plastic cup next to it.

Emissivity Review:

- Emission and reflection are inversely proportional. In other words, a good emitter is a poor reflector and a good reflector is a poor emitter.
- A material's emissivity can affect how it reads in an IR camera and can be deceptive. Keep in mind the material you are attempting to scan when doing IR thermography.
- Shiny metals, in particular, are highly reflective and can give false readings. However, painted metal benefits from the lower reflective properties of paint.

Below is a list of common materials found in and around the home and their emissivity value. Remember, high emissivity (closer to 1) is good for IR thermal imaging. The closer the emissivity is to 0, the more reflective the material is and it will give you an inaccurate temperature reading.

MATERIAL	EMISSIVITY
Asphalt	0.90-0.98
Concrete	0.92
Soil (Dry)	0.90-0.95
Wood	0.94
Gypsum	0.90
Water	0.92-0.98
Ice	0.96-0.98
Snow	0.83
Brick, Mortar, Plaster	0.93-0.96
Acrylic Pain	0.80-0.95
Oil Paints	0.92-0.96
Lacquer (Flat Black)	0.97
Textiles	0.90
Skin (Human)	0.98
Aluminum (Polished)	0.04-0.06
Aluminum (Anodized)	0.55
Steel (Rusty)	0.69
Steel (Stainless)	0.16-0.45
Brass	0.61
Emory-Ground Iron	0.24
Cast Iron	0.64
Copper (Polished)	0.03
Copper (Oxidized)	0.64-0.76
Cork	0.70
Glass (without Low-e coating)	0.93
Granite	0.45
Marble	0.95
Lead	0.43
Plastics	0.94
Porcelain	0.92
Rubber	0.89-0.94
Zinc (Oxidized)	1.0