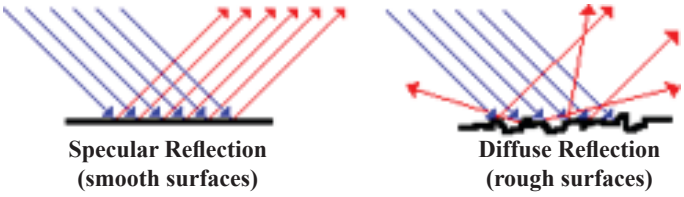
Frequently Asked Questions

1. Why is Spectral Reflectance a better measurement of light output than Total Reflectance?

The reflection of light is extremely predictable. When light strikes a surface, it is either absorbed or reflected. Total Reflectance indicates the percentage of light that is reflected, regardless of the direction it travels after leaving the surface.

A surface's Total Reflectance can consist of both specular and diffuse components. To illustrate this, imagine a ray of light as a tight bundle of smaller, individual rays, all traveling parallel to each other. In accordance with the Law of Reflection, rays that strike a smooth surface will reflect and remain in a concentrated bundle. This is called Specular Reflection and represents a "mirror-like" reflection of light. On the other hand, rays that strike a rough, or diffuse, surface will reflect and scatter in many directions through Diffuse Reflection.



Specular Reflection (smooth surfaces)

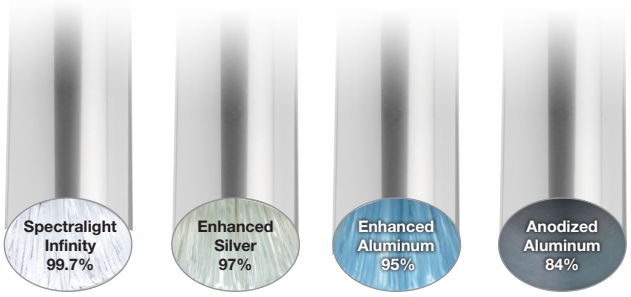
Diffuse Reflection (rough surfaces)

While a diffuse surface can have a high Total Reflectance, the reflected light is scattered, which prevents it from being transmitted in a consistent and tightly-controlled fashion. For TDDs, a high Specular Reflectance is imperative so that light can be efficiently transferred through the system. A Diffuse Reflectance should be avoided since that would result in light being scattered and lost back out through the top of the system.

Although a product may appear to have a high Specular Reflectance, in reality a significant portion of the light may be absorbed by the reflecting surface, as would be the case with a tinted glass mirror or a polished piece of aluminum. In this instance, while the surface functions as a mirror, in actuality 20% or more of the light may be lost by absorption with each reflection. With this example, only five specular reflections may consume all of the available light.

The Spectralight® Infinity Tubing used in Solatube® Daylighting Systems is made of the world's most reflective material, allowing it to achieve a Specular Reflectance of over 99% for visible wavelengths of light (the light we use to see). As such, very little light is lost as it travels through the system, resulting in a highly efficient light transmission rate.

Percentage of light delivered after 20 bounces



0.3% x 20 = **94.17%**

3.0% x 20 = 54.38%

5.0% x 20 = 35.85%

16.0% x 20 = 3.06%

This is critical since even small differences in reflectance values can significantly impact light output. That's because every time a ray of light is reflected, a small amount of that light is lost. The difference of just a few percentage points in Specular Reflectivity makes a huge difference in overall performance. As a result, Solatube International's Spectralight Infinity Tubing is designed to:

- Deliver up to 99.7% specular reflectivity of visible light for maximum daylight transfer
- Allow for long tube runs, which can include up to 90° bends, to deliver consistent daylight to lower floors
- Provide the purest, most consistent spectral reflectance for visible wavelengths of light possible so colors are truer, brighter.

Contrary to Total Reflectance, Specular Reflectance is a key factor in determining an optical tube's efficiency in transferring light, and manufacturers should provide Specular Reflectance data to demonstrate the true efficiency of their TDD systems.

To translate light output into practical applications, Solatube International uses a Design Calculator to evaluate a space by factoring geographic location, time of day and time of year daylight measurements based on the room characteristics, occupancy, and specific Solatube Daylighting System product configuration, including tube length and significant angles. This will develop a custom light study designed to meet specific lighting criteria.

2. What tubing has the most efficient daylight output?

Solatube International's Spectralight Infinity Tubing is made of the world's most reflective material, allowing it to achieve a Specular Reflectance of over 99% for visible wavelengths of light (the light we use to see). Since Spectralight Infinity Tubing is also "spectrally-neutral," meaning that it reflects all the visible wavelengths equally well, it does not change the color of the light that it reflects. As a result, it delivers the brightest, purest daylight without major color shifts over the course of the day. Other tubing materials, such as silver-coated anodized aluminum, enhanced aluminum, and corrugated / flexible, are less efficient and lose significantly more light with each bounce through the tubing. The color of the transferred / reflected light will be changed since these reflective surfaces are not "spectrally-neutral," meaning that they reflect some wavelengths of visible light better than others, therefore, filtering out (absorbing) some colors of light with each reflection. As a result, the color of the reflected light can shift and appear more green / blue or more yellow, depending on the tubing material.

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The L*a*b color model is an excellent way of reporting the color consistency resulting from a reflective material, which is why Solatube International publishes the Spectralight Infinity's L*a*b color indices as part of the product's performance specification. Any company that doesn't publish this data can be suspected of hiding a key performance factor that could result in inadequate product performance.

3. How do I distinguish between the many references for reflectivity?

a) What does 98% reflective tubing with greater than 99% reflective quality mean?

In essence, this statement refers to the fact that the product has a Total Reflectance of 98%, which means that 2% of the light striking the surface is being absorbed (lost) with each reflection. Of the 98% of the light that is reflected, 99% of it is reflected in a specular (concentrated) fashion while 1% of it is reflected in a diffuse (scattered) manner. Thus, this material's Specular Reflectance is actually 98% x 99%, which equals 97%. As a result, 3% of the light is lost from a set of parallel rays of light with each reflection.

b) What is the light output of a product with 98% reflective material in the tubing vs. Solatube International's 99.7% Spectral Reflectance?

To understand what a Total Reflectance of 98% really means, we must first know the specular component, called the Specular Reflectance, of the reflective material used in a tubular system in order to predict how efficiently it can transfer light. This will allow us to determine what the Light Transfer Efficiency of the material is.

As an example, let's say the material is Alanod's Miro Silver Tubing, which has a Specular Reflectance of 97%. That means only 97% percent of the light striking the surface is reflected in a specular (concentrated) fashion. The remaining 3% of the light is lost with each bounce as it travels through a tubular system. The light is either absorbed or scattered through a process called Diffuse Reflection. Over the course of 10 bounces, or reflections, 26.3% (10 bounces x 3%, each) of the light is lost.

Alanod Miro Silver Tubing

97% Specular Reflectance = 3% light loss per individual bounce of light
10 feet of tubing = 10 bounces
10 bounces X 3% individual light loss = 26.3% light loss overall

A higher loss of light can reduce the amount of time that electrical lights can be turned off during the day, reducing energy savings.

In contrast, Spectralight Infinity Tubing, which has a Specular Reflectance over 99% and a Spectral Reflectance of up to 99.7% for visible wavelengths of light, loses only about 0.3% of the light through Diffuse Reflection. Thus, for the same 10 bounces through a tubular system, only 3% (10 x 0.3%) of the visible light is lost, which is one/tenth of the light loss associated with the material stated to be 98% reflective. Thus, even a 1% to 2% difference in Specular Reflectance results in a huge difference in Light Transfer Efficiency (LTE) for a typical tubular daylighting device application.

Spectralight Infinity

99.7% Specular Reflectance = 0.3% light loss per individual bounce of light
10 feet of tubing = 10 bounces
10 bounces X 0.3% individual light loss = 3% light loss overall

4. How did Solatube International's Spectralight Infinity Tubing perform in third party testing?

Third party testing of Solatube's Spectralight Infinity Tubing material through 3M's advanced optical test laboratory proved the validity and reliability of Spectralight Infinity's superior reflectance characteristics for both initial and sustained performance. When used in Solatube International's uniquely engineered daylighting system, the material provides consistent and sustained Specular Reflectance for over 20 years in the field.

5. What is seasonal consistency and why is it important?

The ability of a typical daylighting fenestration product, like a tubular daylighting device, to capture low-angled winter light will differ significantly from its ability to capture high-angled summer light. The ratio of summer to winter light output can be an indicator of the product's effectiveness in delivering (or not delivering) consistent light throughout the course of a year. Ideally, a daylighting product will produce uniform levels of output regardless of season (or climatic conditions), resulting in steady and reliable interior illumination despite variations in exterior conditions or seasonal changes in the daylighting resource.

Solatube Daylighting Systems feature a patented daylight-capturing dome lens and reflector that redirect low-angle sunlight for maximum light capture. This is especially important in winter months when sunlight angles are at their lowest. As a result, Solatube Daylighting Systems are able to deliver daylight for more hours during the day and more consistent light output season to season.

6. What is Color Temperature Maintenance and why is it important?

Color temperature Maintenance (CTM) is a measure of how well a system can deliver reflected light without a color shift. The specific measured L*a*b color model performance parameters associated with a reflective surface are used to determine the specular consistency of light as it is transferred through a tubular system. A high CTM denotes a product that produces minimal color / spectral shift of the light, which makes it a highly desirable light source for interior illumination.

7. What is Visual Transmittance and what relevance does it have to light output?

Visible Transmittance (VT) measures how much light is transferred through a product, and is expressed as a value between 0 and 1. A higher VT value means that a product has greater potential for daylighting.

a) What is Solatube International's Visible Light Transmission? Is there a standard number and how does this compare to other TDDs in the market?

As a highly engineered and optically-complex fenestration product, the Solatube Daylighting System is designed to have a variable Visible Transmittance. This means its VT is engineered to change over time with the sky condition to provide the right amount of controlled light throughout the day and year, regardless of climate or geographical location. In reality, the "perfect" daylighting product is engineered to selectively harvest light from the sky vault to produce consistent and useful light output even as exterior daylight conditions change with the time of day, time of year, and ever-changing sky condition. A single VT rating is meaningless unless it actually represents a product's performance over an actual year. As a result, Solatube International has led the Fenestration Industry by working with NFRC and DOE's Lawrence Berkeley National Laboratory (LBNL) to develop a new, annual VT rating that is derived from the wide range of product visible transmittances encountered throughout a year for a "Middle America" geographic location. This new VT annual rating does not represent the maximum, ideal VT, but rather a real-world performance for a product located at a "Middle America" North American latitude of 40 degrees. As such, it has a very different, and much more useful, meaning in how a product will transmit light over the course of a year.