Interference Fringes in Insulating Glass Units

Definition
Lite - *another term for a pane of glass used in a window, as in "a lite of glass". Frequently spelled "light" in the industry but spelled "lite" in this text to avoid confusion with light as in "visible light".*

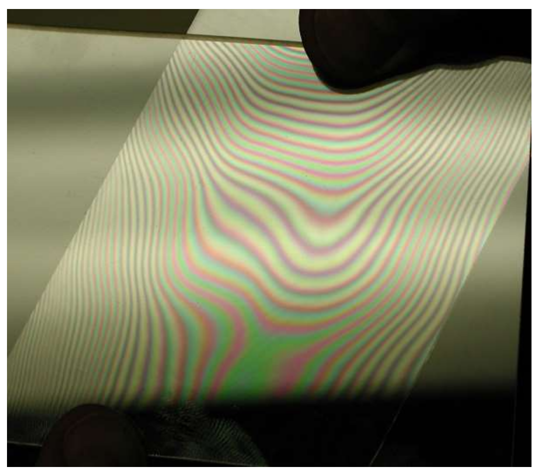
There have been several documents written regarding interference fringes in insulating glass units. There seems to be a great deal of vagueness and, in some cases, incorrect explanations of the types of fringes and how and why they occur. The bottom line, however, in all that has been written, is that interference fringes are an optical phenomenon, not a glass defect. In fact, the more optically pure and the more uniform in thickness the glass, the more likely it will be for fringes to occur when two or more pieces of glass are put together.

In short, interference fringes in insulating glass units are the result of an interaction between colliding light waves. Because of reflections off the multiple glass surfaces in IG units, light waves divide and travel different paths, then recombine. When they recombine, interference fringes may be seen.

The most common names are "Newton's Rings" and "Brewster's Fringes". These are considered to be two different phenomena, although they are similar and are occasionally referred to as the same thing.

Newton's Rings
"Newton's Rings" are named after Sir Isaac Newton (1642-1727), who did detailed studies of the phenomenon, although it is said that he did not correctly explain it. Some sources indicate that Robert Hooke (1635-1703) actually discovered this type of interference fringes.

"Newton's Rings" are interference fringes that occur when two pieces of glass are in contact and are usually brighter and more easily seen than "Brewster's Fringes". The glass plates are actually separated by a thin film of air. Very small variations in the thickness of the air film can cause the fringes to show up as straight lines, circular rings, or somewhat irregular lines like the lines on a topographical contour map, as can be seen in the photograph below.



Changing viewing angle can make the fringes appear to move slightly and may affect their brightness and color. They are most often seen in rainbow-like colors but may also be nearly gray in color. If the pieces of glass are pressed tightly together, the air gap is thinner and the fringes will be more colorful, wider and further apart. If the air film is thicker, the fringes will be thinner, closer together, and will tend toward gray in color.

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In insulating glass units, Newton's Rings may become visible if the airspace collapses or shrinks to the degree that the two lites of glass touch at the center.

Brewster's Fringes

"Brewster's Fringes" are named after Sir David Brewster (1781-1868). He was a professor of physics, and the inventor of the kaleidoscope. In his studies of light, he made discoveries in double refraction and in spectrum analysis.

If fringes are seen in an insulating glass unit, and the lites of glass are not touching, then we usually refer to this phenomenon as "Brewster's Fringes".

Optical paths

There are two different optical paths capable of producing Brewster's fringes in IG units (see Figures 1 & 2), and they result in two different types of fringes, which we will call type 1 and type 2.

Type 1 fringes are a fairly strong optical phenomenon and are usually brighter than type 2. Type 1 fringes are most often noticed as colored or rainbow-like. If the two glass plates in an IG unit are very nearly the same thickness, the optical paths are nearly the same, and type 1 interference fringes occur.

Type 2 fringes are a relatively weak optical phenomenon and are considered to be negligible even though they can be seen under some viewing conditions in all double glazed IG units made with float glass, and they can occur, even in IG units with two different thicknesses of glass. Type 2 fringes usually tend to appear gray in color, or they may have a very faint, almost undetectable rainbow-like appearance.

Here's what occurs to generate Type 1 fringes (See Figure 1 on page 4)

First, both sheets of glass in the IG unit are of nearly identical thickness and refractive index. Light travels through the first lite. Part of the light goes on to lite 2, and part of the light is reflected off surface 2, back to surface 1, reflected off surface 1, then travels on to surface 3. The original portion of light that travels on to the second lite, passes through lite 2, and is reflected off surface 4. Since the sheets of glass are of nearly identical thickness, the reflected portions of the light recombine at the third surface, and interference fringes occur.

Since thickness variations in float glass can be very small, when two adjacent pieces of glass are cut from the float glass ribbon and assembled into an insulating glass unit, it is possible that type 1 interference fringes may be visible under some viewing conditions.

Here's what occurs to generate Type 2 fringes (See Figure 2 on page 5)

Light travels through the first lite. Part of the light goes on to lite 2, and part of the light is reflected off surface 2, back to surface 1, reflected off surface 1, then travels back through lite 1 then on to surface 3. It then reflects off surface 3, travels back through lite 1 and is reflected off surface 1 back toward surface 2. At the same time, another portion of the light travels through lite 1, reflects off surface 2, travels back through lite 1 to reflect off of surface 1. It then travels on to surface 3. There it reflects back to surface 2 and

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recombines with the other portion of light to form interference fringes.

Type 2 fringes may be seen when the lites of glass are of different thickness. Because these fringes usually appear nearly gray in color, they are less noticeable than Type 1 fringes. They may be present but may go completely unnoticed.

Viewing

If fringes are present, they can be seen by looking at either the reflecting or the transmitting side of the IG unit under certain viewing conditions.

Viewing from the reflecting side

Type 1 fringes are most visible if the incident angle of the light source is ~60° and the viewing angle is from 0 - 30° from perpendicular to the glass surface.

Type 2 fringes are most visible if the incident angle of the light source is ~75° and the viewing angle is > 30° from perpendicular to the glass surface. Type 2 fringes have negligible visibility when viewed straight on.

Viewing from the transmitting side

When viewing from the transmitting side, both type 1 and type 2 are most visible if the incident angle of the light source is >80° from perpendicular to the glass surface.

Controlling fringes

Type 1 fringes may be controlled to a degree by the following:

1. Using glass from two separate racks or pallets.

2. Using glass from two separate rows in a rack or pallet.

3. Reversing end for end every other lite within a rack or pallet.

4. Type 1 fringes may be eliminated by using two different thicknesses of glass to make the IG units. However, the thickness ranges must not overlap. Different sources quote different numbers for the thickness difference required to reduce the likelihood that *type 1* fringes will be visible, i.e., >.00006”, >.0002”, >.0001”, >.003”. We suggest that the thicknesses should be different by about .002” to .004”.

5. Type 2 fringes cannot be eliminated but are usually negligible or unnoticeable. However, from time to time, the lighting and viewing conditions may be such that they will be visible.

NOTE:

This is not the same phenomenon as anisotropy or the “strain pattern” that is sometimes seen in tempered and heat strengthened glass. See TD-115 for an explanation of that phenomenon.

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Figure 1

Type 1 Fringes

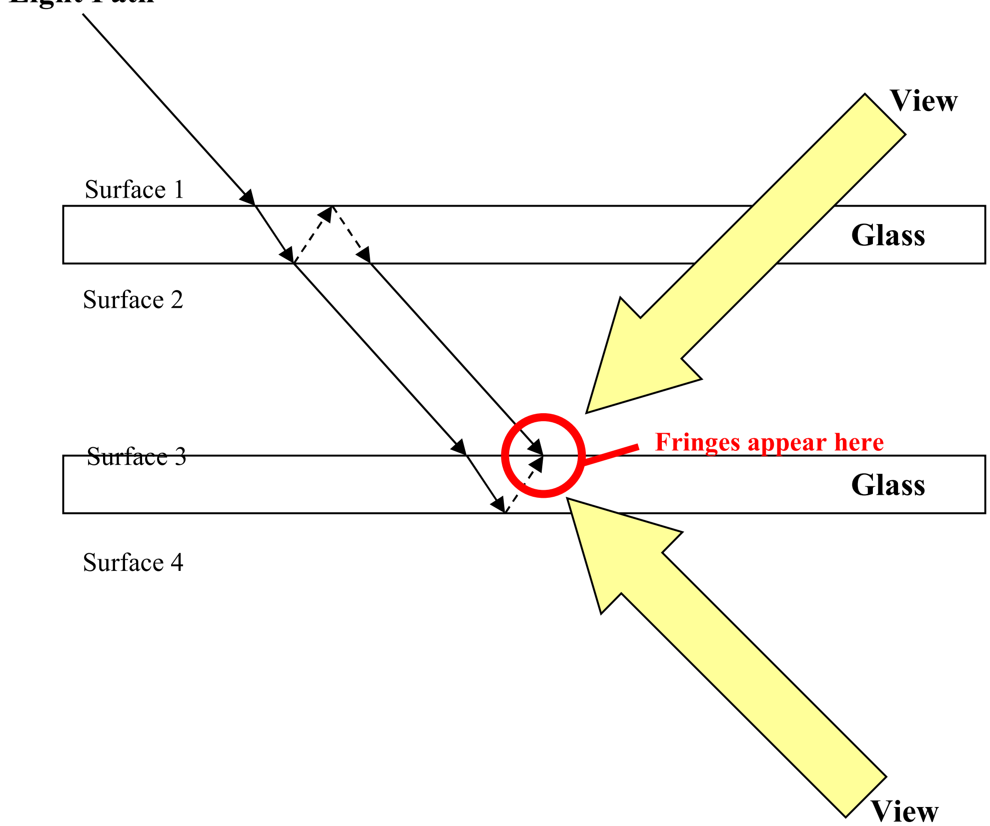

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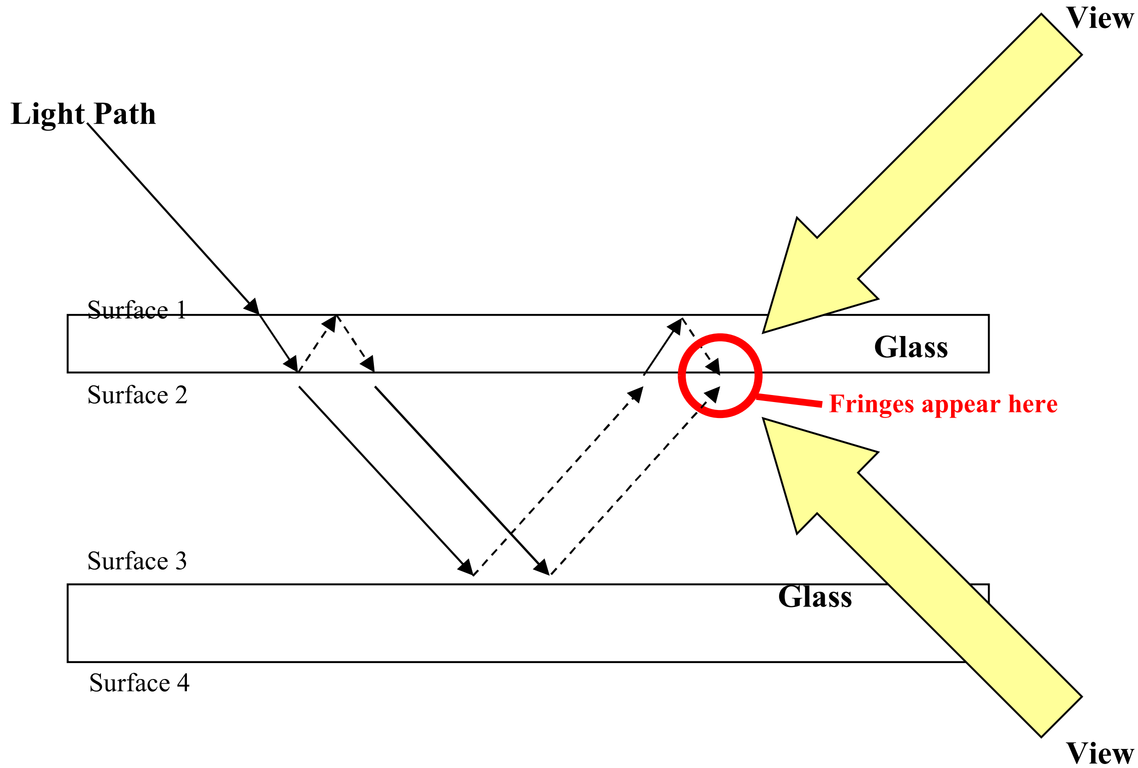
Figure 2

Type 2 Fringes



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HISTORY TABLE		
ITEM	DATE	DESCRIPTION
Original Publication	7/23/2002	TD-118
Revision #1	10/04/2016	Updated to Vitro Logo and format
Revision #2	1/25/2019	Updated the Vitro Logo and format
Revison #3	10/5/2024	Minor content updates and verification