**Refraction**

![Refraction Controls]

**Color**

Transparency color multiplies the refracted result by a color. For tinted glass it is best to control the tint color via the Transmittance color since it actually filters the refraction according to the distance traveled by the refracted ray.

![Color Gradient]

If this value has a color and shadows tinted with that color are required then disable 'opaque' for the mesh that has been assigned the Standard material. In the example below, you can see that with Opaque enabled the rays cannot pass through the sphere. Whereas with Opaque disabled, the rays can pass through the sphere and absorb the color set by the transmittance, thereby creating the effect of colored shadows.
Weight

Transparency allows light to pass through the material.

Index of Refraction

The index of refraction used. The default value of 1.0 is the refractive index of a vacuum, i.e., an object with IOR of 1.0 in empty space will not refract any rays. In simple terms, 1.0 means 'no refraction'. The Standard shader assumes that any geometry has outward facing normals, that objects are embedded in air (IOR 1.0) and that there are no overlapping surfaces.

Note that you must disable ‘Opaque’ for the mesh that has been assigned the Ai Standard shader.
When rendering transparent and refractive surfaces it is very important that the normals of the geometry face in the right direction. In the example below you can see the difference between normals that are facing in the right direction (outward) versus those that are facing inwards (incorrect). This is especially important when rendering surfaces with double sided thickness, such as a glass.

The direction of the normals is equally important when rendering single sided surfaces. The windscreen model below is single sided. The difference is clearly visible when the normal direction is facing in the wrong direction.
Normals pointing inwards: Incorrect
Windscreen glass looks wrong

Normals pointing outwards: Correct
Windscreen glass renders correctly

If you can only see black where there should be refraction, you may not have a high enough refraction ray depth value (found in the Ray Depth section in the Render Settings). The default value is two.

**Dispersion Abbe Number**

Specifies the Abbe number of the material, which describes how much the index of refraction varies across wavelengths. For glass and diamonds this is typically in the range of 10 to 70, with lower numbers giving more dispersion. The default value is 0, which turns off dispersion. The chromatic noise can be reduced by either increasing the global Camera (AA) samples, or the Refraction samples.
Roughness

Controls the blurriness of a refraction computed with an isotropic microfacet BTDF. The range goes from 0 (no roughness) to 1.

Fresnel use IOR

Calculates Fresnel reflectance based on the IOR parameter, ignoring the values set in Krn and Ksn.
The images below show the effect that increasing the Index of Refraction has on the Fresnel reflectance.

Transmittance

Transmittance filters the refraction according to the distance traveled by the refracted ray. The longer light travels inside a mesh, the more it is affected by the Transmittance color. Therefore green glass gets a deeper green as rays travel through thicker parts. The effect is exponential and computed with Beer’s Law. It is recommended to use light, subtle color values.

In the example below, you can see this difference in the bottom of the glass. The glass with Transmittance color appears more physically accurate than the glass that uses Refraction color.
The effect of Transmittance color is even more obvious in the example below. You can see that the white shapes become darker as they go deeper below the surface when using Transmittance.

The images below show the effect of transmittance between a color value range of 0.8 and 1 (with a green tint).
Opacity

Controls the degree to which light is not allowed to travel through it. Unlike transparency, whereby the material still considers diffuse, specular etc, opacity will affect the entire shader. Useful for retaining the shadow definition of an object, whilst making the object itself invisible to the camera.

You must ensure that 'Opaque' is disabled for the mesh that the Standard shader is assigned to when using 'Opacity'.

Transmittance color is scene scale dependent which can have a dramatic effect on its appearance. If you cannot see the effect of Transmittance color then you may need to check the size of your scene.

Transmittance effect is more noticeable when cube is scaled up
Exit Color

Use Environment

Specify whether to use the environment color for refraction rays where there was insufficient ray depth (true), or the color specified by refraction_exit_color (false).

Refraction Exit Color

More information about working with Opacity can be found here.
The color returned when a ray has reached its maximum refraction depth value.