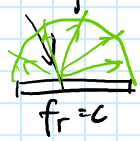
Material & Appearance

2021年9月12日 10:33

The appearance of Natural Materials

1. Diffuse / Lambertian Material

Light is equally reflected in each direction.

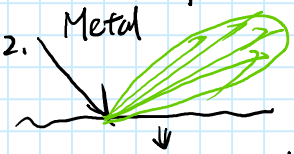


$$L_o(w_o) = \int_{H^2} f_r L_i(w_i) \cos\theta_i \, dw_i$$
$$= f_r L_i \int_{H^2} \cos\theta_i \, dw_i$$
$$= \pi f_r L_i$$

$$\therefore f_r = \frac{\rho}{\pi}$$ ρ: albedo (color)

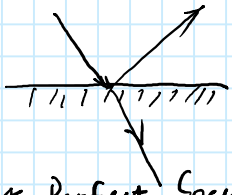
for white objects, $\rho = 1$

2. Metal



Glossy material

3. Glass / Water



4. Perfect Specular Reflection BRDF

5. Specular Refraction.

"Caustics"

Diamond: $n = 2.42$ especially high. thus. looks special

$$\eta_i \sin\theta_i = \eta_t \sin\theta_t$$
$$\cos\theta_t = \sqrt{1 - \sin^2\theta_t}$$
$$= \sqrt{1 - \left(\frac{\eta_i}{\eta_t}\right)^2 (1 - \cos^2\theta_T)}$$

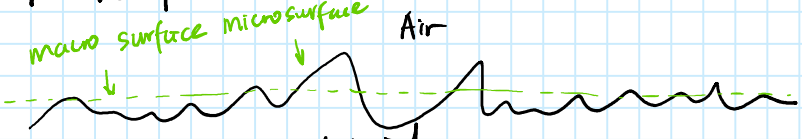
会发生全反射. 在 path tracing 时要注意

6. Fresnel Term

Schlicks approximation

$$R(\theta) = R_0 + (1 - R_0)(1 - \cos\theta)^5$$
$$R_0 = \left(\frac{n_1 - n_2}{n_1 + n_2}\right)^2$$

7. Microfacet material



Macro scale: flat & rough

Micro scale: bumpy & specular

Microfacet BRDF

Key: distribution of microfacets' normals

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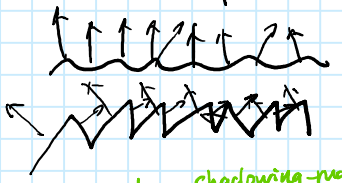

Fresnel　shadowing-masking term (Geometry term)　→ distribution of normals

$$f(i,o) = \frac{F(i,h)\,G(i,o,h)\,D(h)}{4(n,i)(n,o)}$$

8. Isotropic / Anisotropic 各向同性/各异性　"VRay renderer"

Anisotropic BRDF

$f_r(\theta_i, \phi_i; \theta_r, \phi_r) \neq f_r(\theta_i, \theta_r, \phi_r - \phi_i)$

↑ 方位角

eg. Nylon

9. Properties of BRDF

- Non-negative
- Linearity
- Reciprocity principle
  $f_r(w_r \to w_i) = f_r(w_i \to w_r)$
- Energy conservation
  $\forall w_r \int_{H^2} f_r(w_i \to w_r)\cos\theta_i\, dw_i \leq 1$

10. Measuring BRDF

MERL BRDF Database.

90 * 90 * 180 measurement