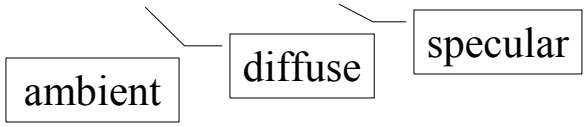
BRDF

Today's Topics

- Discussion of Debevec's SG96 paper.
- Introduction to local reflection model and BRDF.
  - Similar to the 3/1/04 lecture in CS5502 last semester.

Phong Reflection Model

- I = Ka*Ia + kd*Id + Ks*Is



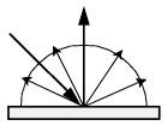
- Not completely correct, but good enough.

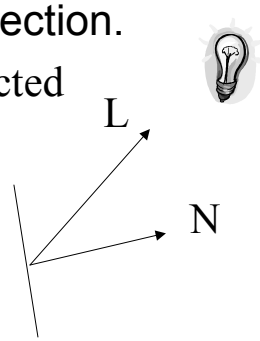
Ambient Component

- Accounting for light scatter around.
- Ia is constant.

Diffuse Component

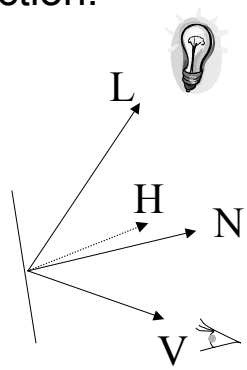
- $Ia = Ii * N \cdot L$
- Not affected by viewing direction.
  - i.e., incoming light is reflected to all directions.





Specular Component (Phong Reflection Model)

- To model imperfect reflection.
- $Is = Ii(N \cdot H)^n$



Summary of Phong Reflection Model

- $I = Ka*Ia + kd*Id + Ks*Is$

  $= Ka*Ia + \{Kd*(N \cdot L) + Ks*(N \cdot H)^n\} * Ii$

- Where is color? Set Ka and Kd for RGB.

  $Ir = Kar*Ia + \{Kdr*(N \cdot L) + Ks*(N \cdot H)^n\} * Ii$

  $Ig = Kag*Ia + \{Kdg*(N \cdot L) + Ks*(N \cdot H)^n\} * Ii$

  $Ib = Kab*Ia + \{Kdb*(N \cdot L) + Ks*(N \cdot H)^n\} * Ii$

- Ka and Kd depend on material color, Ks depends on the light (which is white in the above case).

Phong Reflection Model (continued)

- We had:

  $Ir = Kar*Ia + \{Kdr*(N \cdot L) + Ks*(N \cdot H)^n\} * Ii$

  $Ig = Kag*Ia + \{Kdg*(N \cdot L) + Ks*(N \cdot H)^n\} * Ii$

  $Ib = Kab*Ia + \{Kdb*(N \cdot L) + Ks*(N \cdot H)^n\} * Ii$

- Alternatively:

  $I = \{Ka*Ia + Kd*Ii*(N \cdot L)\} * object\_color$

  $+ Ks*Ii*(N \cdot H)^n * light\_color$

"But, they all look like plastic…"

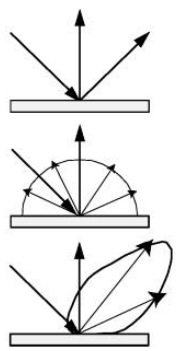
Specular Component (Cook & Torrance Model)

- Consider specular reflection as perfect reflection of micro-facets. (See Watt's Section 7.6)
- Specular=DGF/($N \cdot V$)

  D: Distribution term

  G: Geometry (shadowing and masking) term

  F: Fresnel term

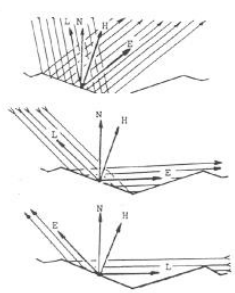


D Term (Cook & Torrance)

- Modeling the distribution of micro-geometry.
- Gaussian distribution can be used:

$$D = k\, e^{-(\alpha/m)2}$$

G Term (Cook & Torrance)



$$G = \min(G_a, G_b, G_c)$$

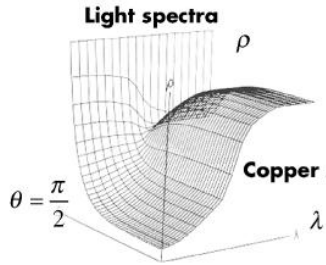
$$G_a = 1$$

$$G_b = \frac{2(\mathbf{N} \bullet \mathbf{H})(\mathbf{N} \bullet \mathbf{E})}{(\mathbf{H} \bullet \mathbf{E})}$$

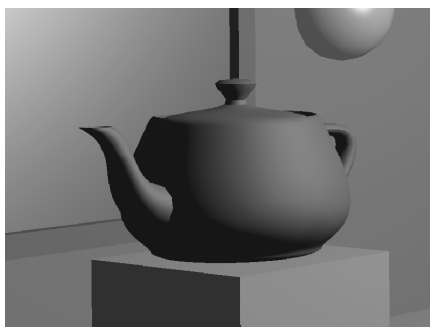
$$G_c = \frac{2(\mathbf{N} \bullet \mathbf{H})(\mathbf{N} \bullet \mathbf{L})}{(\mathbf{H} \bullet \mathbf{L})}$$

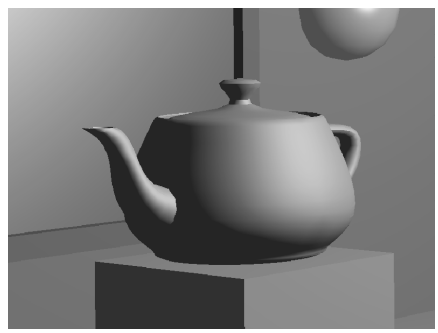
The Fresnel Term

- Color of reflected light varies with viewing angle.
- Detailed formula in Watt's 7.6.4



Reflectance of Copper as a function of wavelength and angle of incidence





From Watt's color plate Figure 7.8. These would be difficult to obtain by fine-tuning the parameters in Phong model.

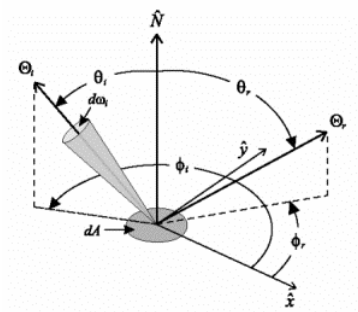
"Now, are all materials covered?"

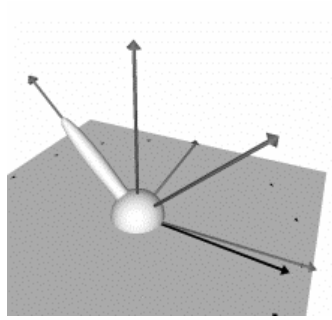
No!

Let's try a sample-based method instead…

BRDF

- BRDF=f(θ_{in}, ϕ_{in}, θ_{ref}, ϕ_{ref})=f(L,V)





Why Not Always Using BRDF?

- Difficult to find a “closed form” representation of BRDF.
- The Phong model and Cook & Torrance model are approximation of BRDF.
  - They are not 100% match of BRDF, but they are easy to compute.