

20. Light Emitting Fluids

Monday, November 2, 2020

Check out eqpt Thursday

Today: Light emitting fluids (last of dye/molecular techniques), then particles as seed.

Recap, Dye Techniques

Want dye to have strong interaction with light, to create contrast to unseeded fluid.

How does dye, or any matter interact with light?

- 1) Reflection
- 2) Refraction
- 3) Diffraction
- 4) Absorption

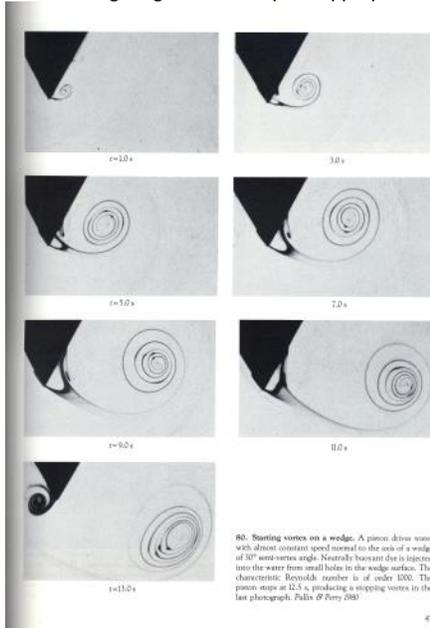
4) Absorption

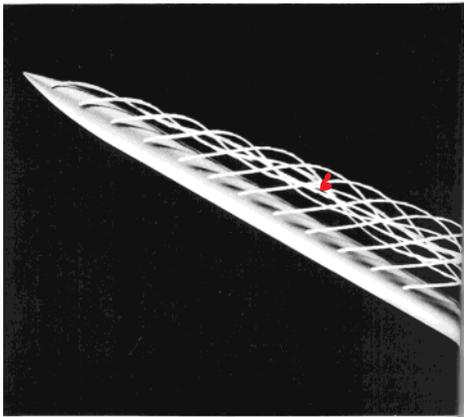
Normal sight in white light; all colors (wavelengths) are absorbed except the one we see, which is diffuse reflected to our eyes

- Dispersion, any of these, but
 - Affects differently based on **wavelength**
 - leads to chromatic aberration, prisms, cloud iridescence (maybe diffraction around particles; interference)
 - Birefringence = 2 indexes of refraction

http://www.ualberta.ca/~pogosyan/teaching/PHYS_130/FALL_2010/lectures/lect35/lecture35.html

Make sure lighting and backdrop are appropriate for the type of light interaction.





87. Attached vortex pair behind an inclined slender body. A long open-cylinder is inclined at 30° to water flowing at 4 cm/s. At this angle of attack, a symmetric pair of vortices forms on the lee side of the body. Coloured fluid emitted under slight pressure from 0.3-mm holes spirals around the core of the nearest vortex. The Reynolds number is 800 based on the diameter of 1 cm. *Fischer 2009*

E.g.:

Dye = dark food color. Absorption is primary, so use bright backdrop

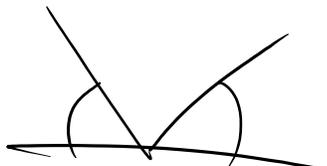
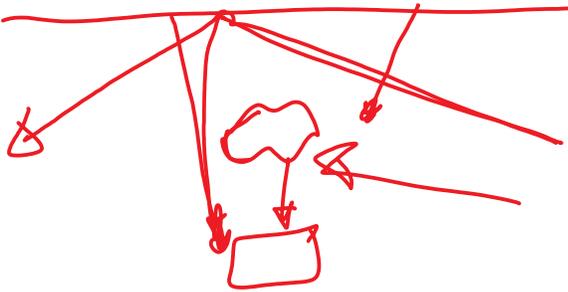
Dye = milk. Scatter is primary; use black backdrop

10% → Minute paper: Which is better for a dark backdrop like the above picture:

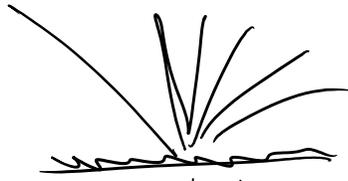
A) smooth, maybe shiny

B) matte, not shiny, maybe textured?

90% →

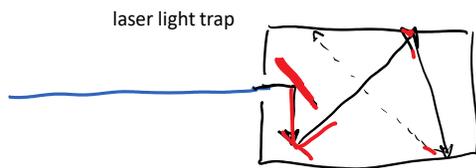


Specular



Maximize absorption
Diffuse

Smooth is good if you can control what the specular reflection shows. If not, rough is better.



For maximum absorption:

Vantablack is the trademarked name (owned by Surrey NanoSystems Limited) ^[1] for a [chemical](#)

substance made of [vertically aligned carbon nanotube arrays](#)^[2] and is one of the [darkest](#) artificial substances^[3] known, [absorbing up to 99.965% of radiation in the visible spectrum](#).^{[4][5]}

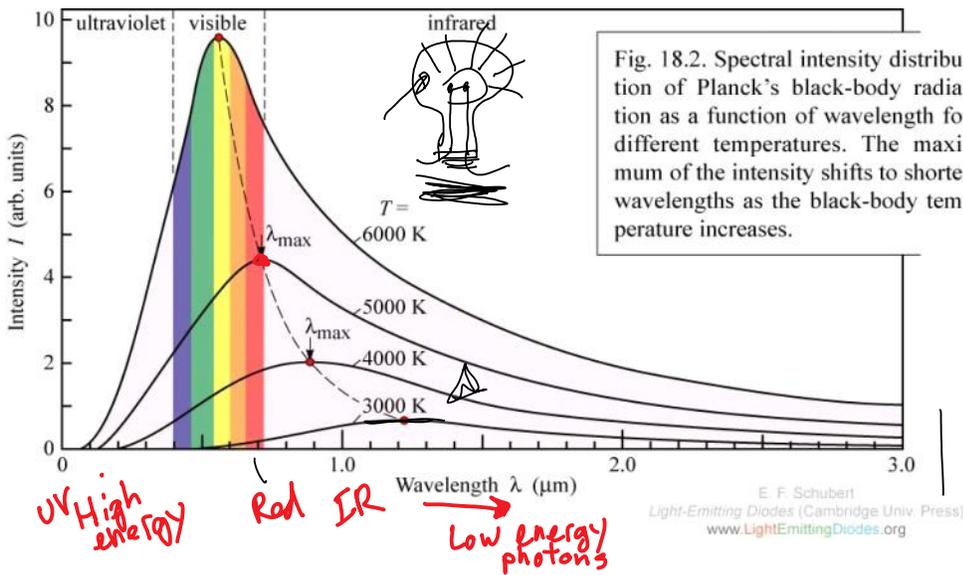
From <https://en.wikipedia.org/wiki/Vantablack>

Vantablack S-VIS, a sprayable paint that uses randomly-aligned carbon nanotubes and only has high absorption in the [visible light](#) band, has been [exclusively licensed](#) to [Anish Kapoor](#)'s studio for artistic use.^[18] This has caused outrage among some other artists, including [Christian Furr](#) and [Stuart Semple](#).

From https://en.wikipedia.org/wiki/Vantablack#Exclusive_licence_within_arts

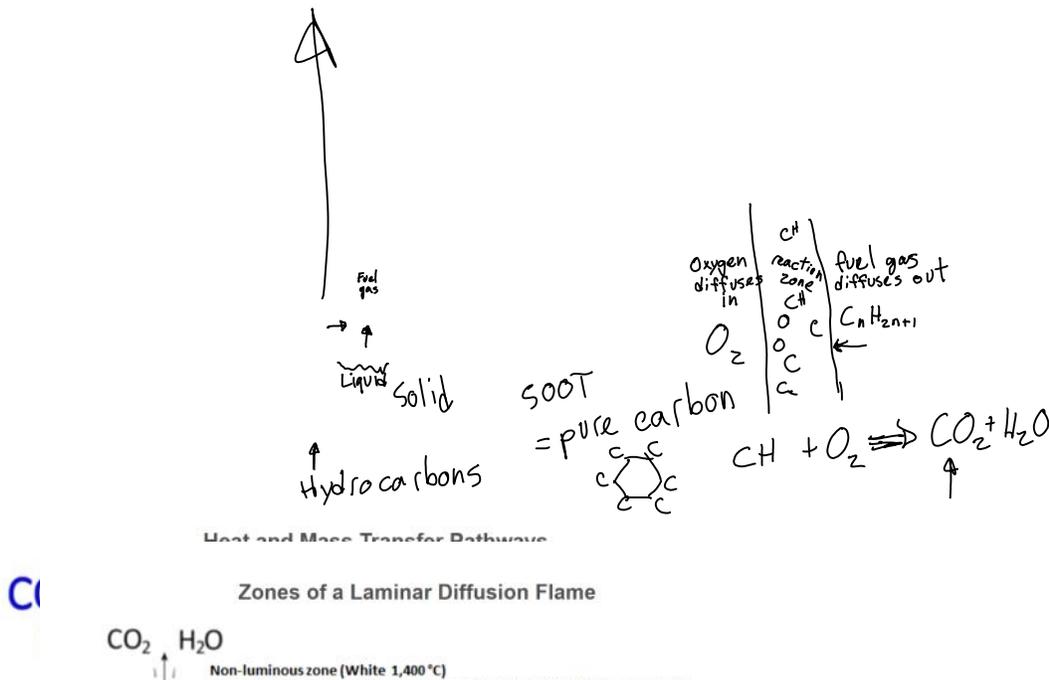
Light Emitting fluids: Photons are emitted for a range of reasons.

Black Body Radiation = yellow flame color, from BBR of soot particles. Random λ (wavelength) photons from thermal energy. Has a peak, but is very broad band.



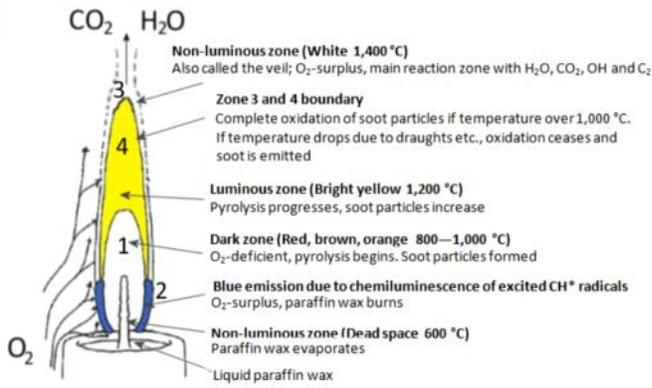
https://www.phy.questru.ca/rknop/classes/enma/2010-10/wiki/images/8/84/Black_body.jpg

Yellow flames: candles, wood fires. Happens when fuel and air are not premixed, when there is excess carbon. Carbon collects together into microscopic soot particles that are hot! Gives off BBR, thermal photons corresponding to temperature.



U

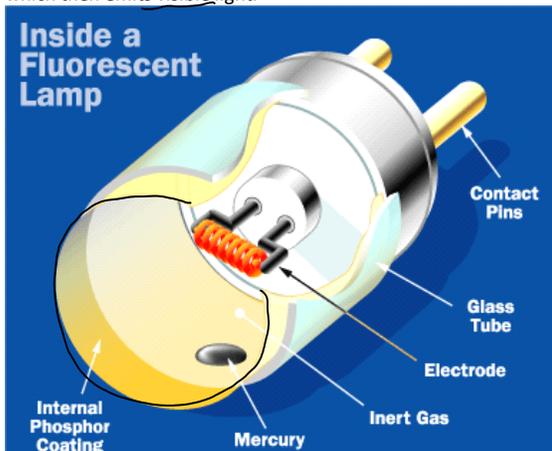
Zones of a Laminar Diffusion Flame



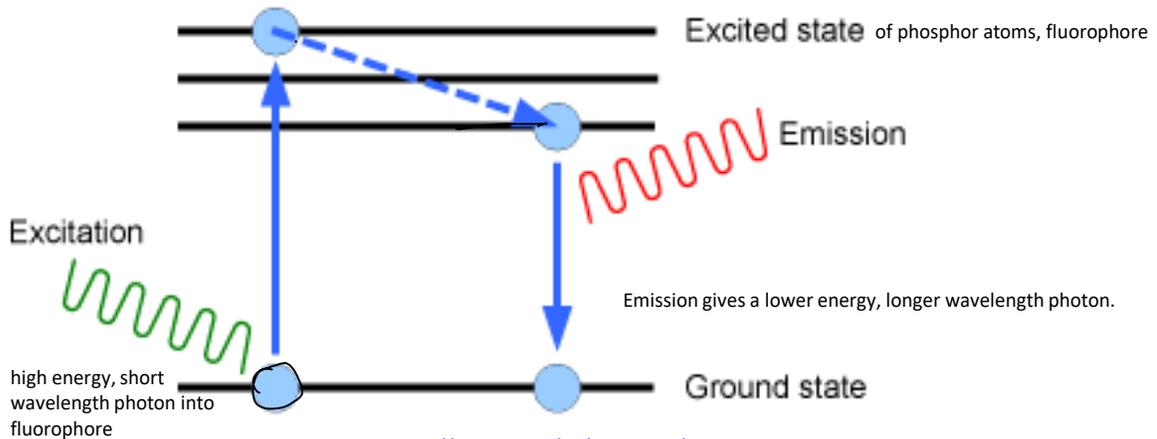
© Wiley-VCH
Source: K. Roth, Chemistry of the Christmas Candle — Part 2, DOI: 10.1002/chem.201000146

fabric softener — absorb UV photon from sunlight
whites look whiter
emit blue or orange

Luminescence = cold body emission, usually at specific λ .
Fluorescence = absorption of photons at a specific short λ , emits at a longer λ .
 E.g. some laundry detergents and fabric softeners absorb in the UV, and emit blue or orange
 Fluorescent bulbs: Current is conducted through mercury vapor, energizes it to emit UV photons which hit a phosphor coating on the inside of the tube, which then emits visible light.



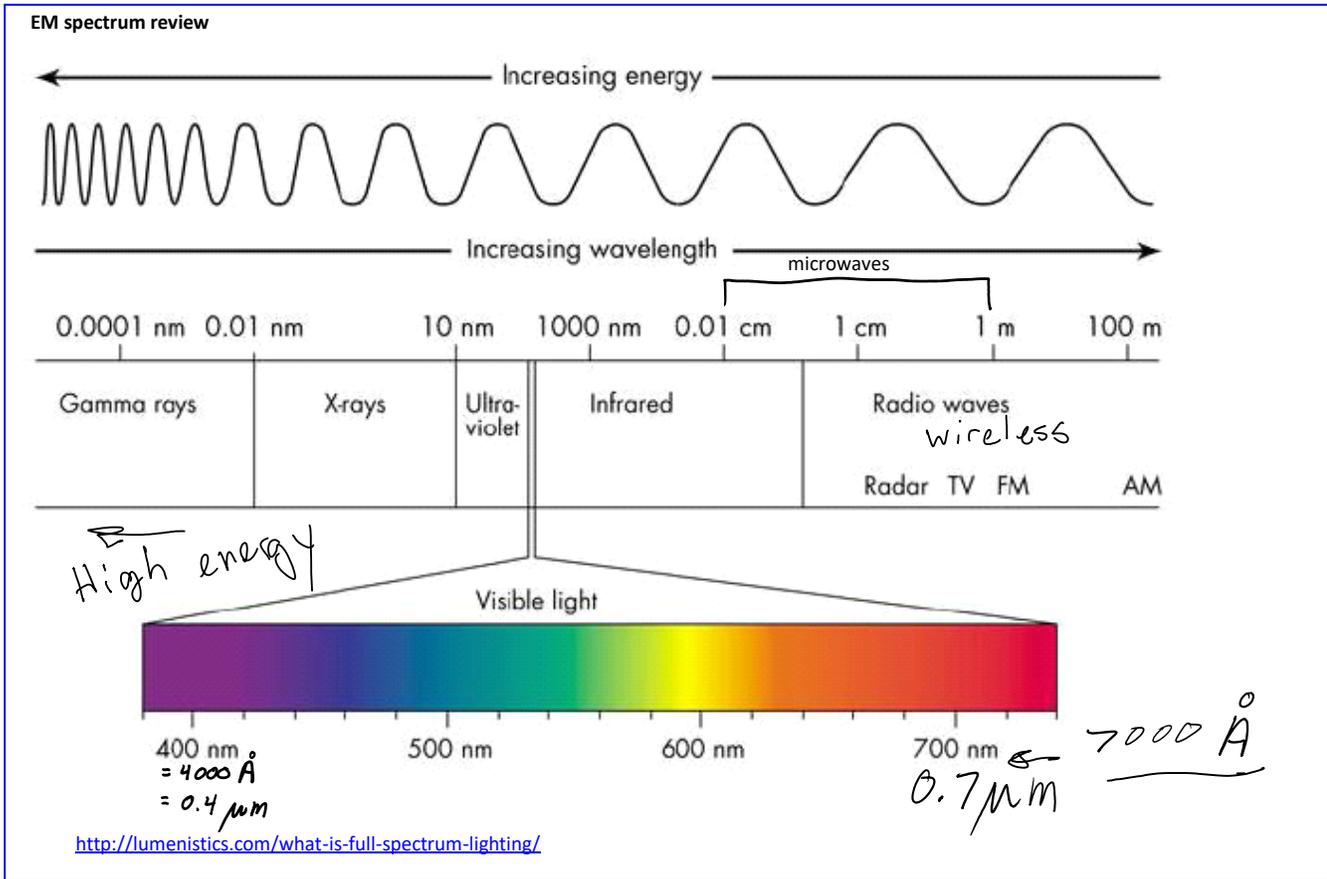
<http://home.howstuffworks.com/fluorescent-lamp.htm/>



<http://www.art.ca/en/preclinical/optical-molecular-imaging/fluorescence.php>

Wavelength change between absorption and emission = Stokes shift:

- some heat lost from excited state,
- and/or returns to ground state + highest vibrational mode, not all the way down.



Chemoluminescence - Cyalume, party bracelets: chemical reaction releases photon, which then drives fluorescence. Needs mix of chemicals for reaction, and choice of color.
 Flames: C_2 , CH^+ , radicals = highly reactive intermediate molecules (between reactant and product species) that only exist in the thin reaction zone. Excited by reactions, emit blue photons to get to lower energy state.
 Also, hot soot gives off black body radiation; yellow glow.

<https://www.aldacenter.org/outreach/flame-challenge>



Burner flame

Bioluminescence - Fireflies, deep sea fish, worms. Good for flow vis?

<https://www.youtube.com/watch?v=Fvob6L8q3I8> Red tide, blue waves off San Diego

Ocean wakes plankton
Life of pi



Electroluminescence - LEDs, sodium vapor, mercury vapor lamps etc. Specific λ .

E.g. electric pickle <http://www.youtube.com/watch?v=MhXCG6k6oA>

Laser : population inversion, specific λ , resonant cavity with mirrors. Gas dynamic laser: after supersonic expansion, lower vibrational states relax before higher ones = inversion. A type of 'chemical laser'



<https://www.nationalgeographic.com/animals/fish/group/anglerfish/>

See cyalume party bracelets

8 Inch Triple Wide Glowstick	8 Inch Glowstick Bracelets - 8 ...	1728ct Bright Jelly Bracelet ...
\$0.01	\$0.01	\$41.69
Glow Universe	Glow Universe	Oriental Tradin...
★★★★★ (3)	★★★★★ (6)	Special offer