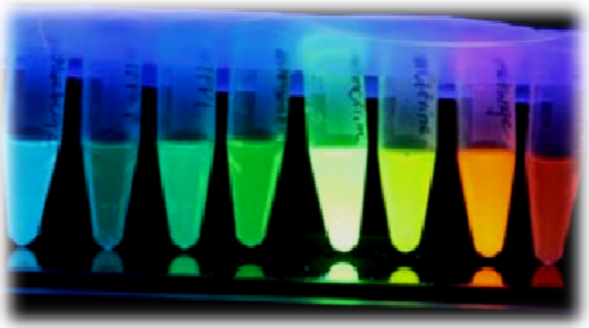
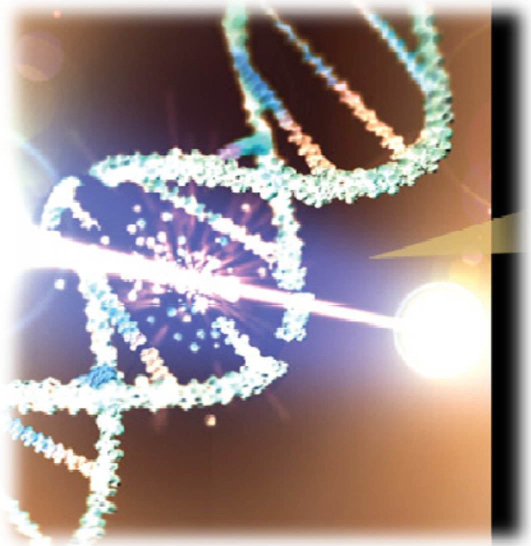
Chemical Technology of Materials

UV-light applications

Krzysztof Gugula
and
Alexander Milbrat



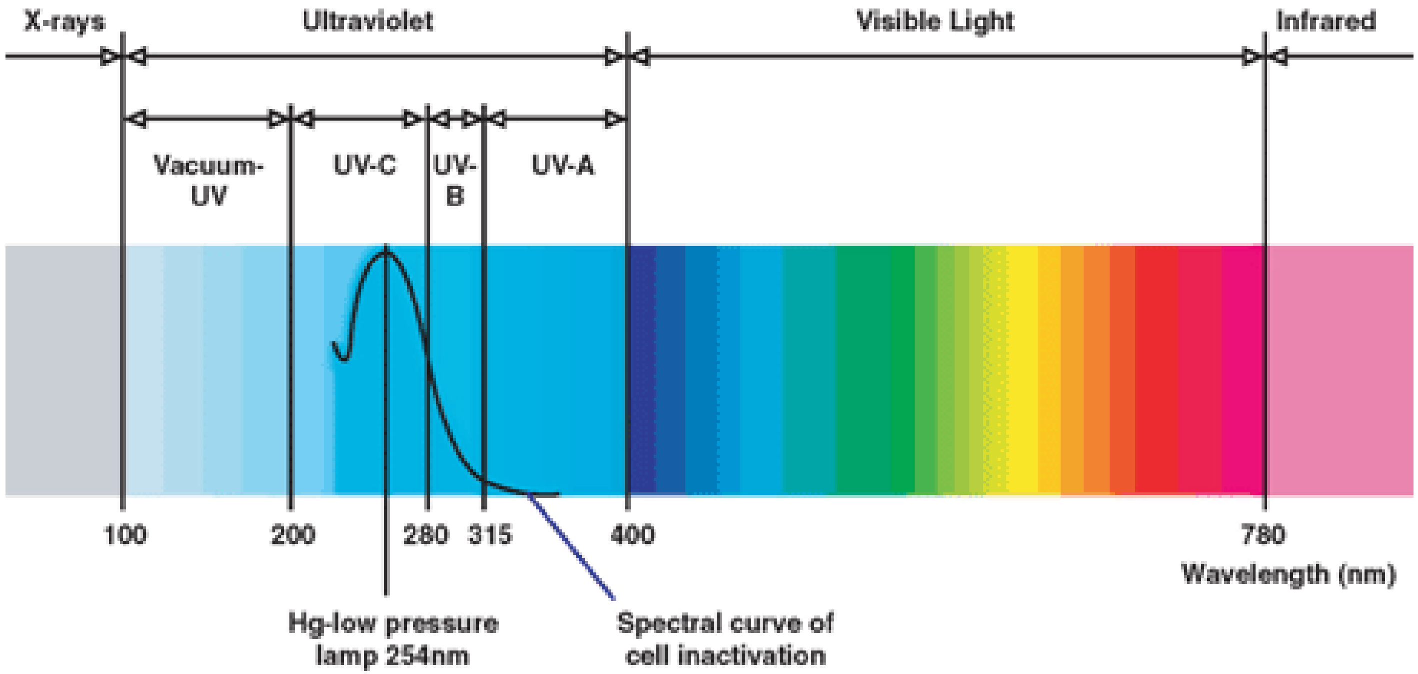


Outline

1. UV light spectra
2. Low-pressure mercury lamp
3. UV applications
   - Disinfection of water
   - Security
   - Quality control
   - Electronics
   - Other applications
4. References

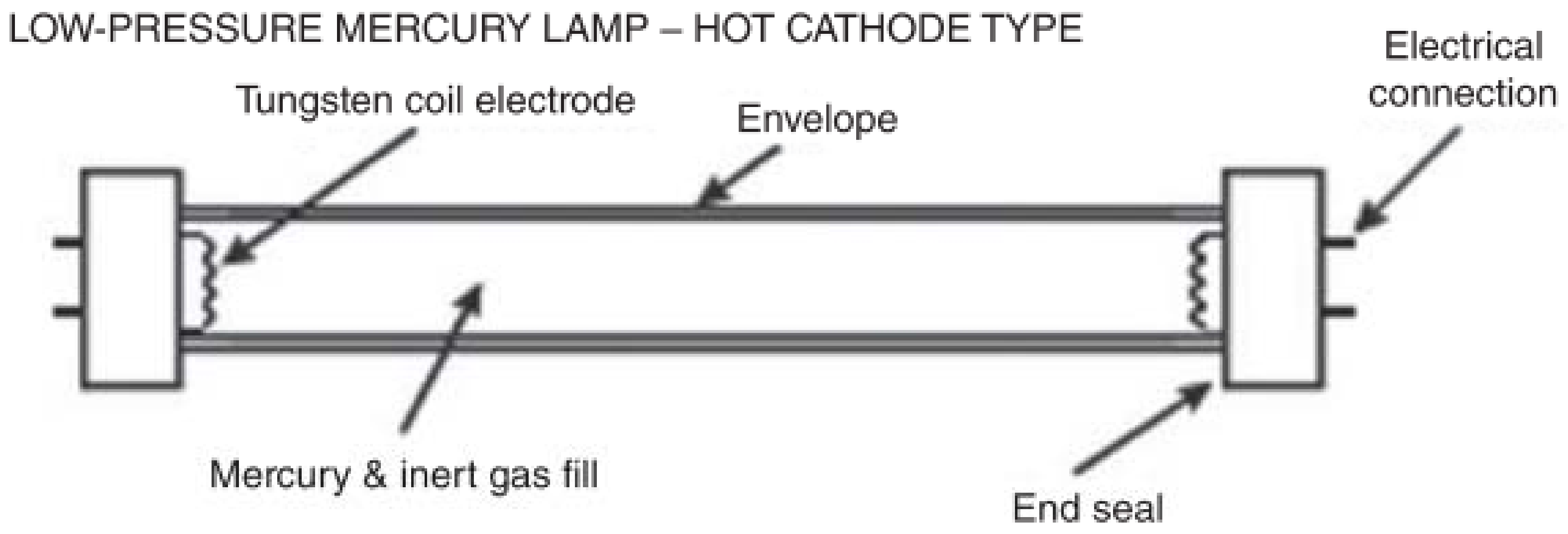
UV light spectra

- UV-A: damages collagen fibers => accelerate skin aging
- UV-B: essential for vitamin D production, leads to sunburn
- UV-C: most dangerous for living organisms, use for disinfection



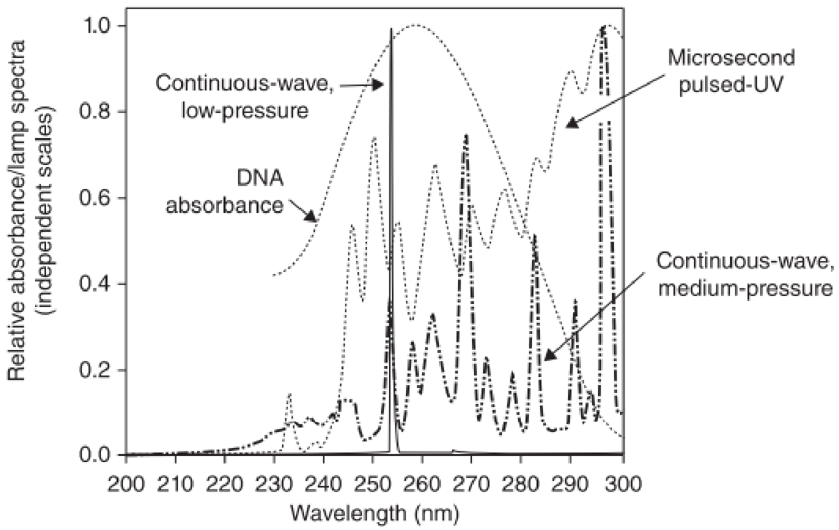
Low-pressure mercury lamp

- Electrical arc excites mercury
- Emission of mercury is essentially at 254 nm



Disinfection of water

- Bacteria are "killed" by photochemical changes in DNA or RNA
- Light of sufficient energy has to be used which can be absorbed from the DNA



Source: Linden & Mofidi 2000, unpublished data

Figure 17.2. Comparison of wavelength regions of optimal disinfection to DNA absorbance and wavelengths of emission from UV lamps.

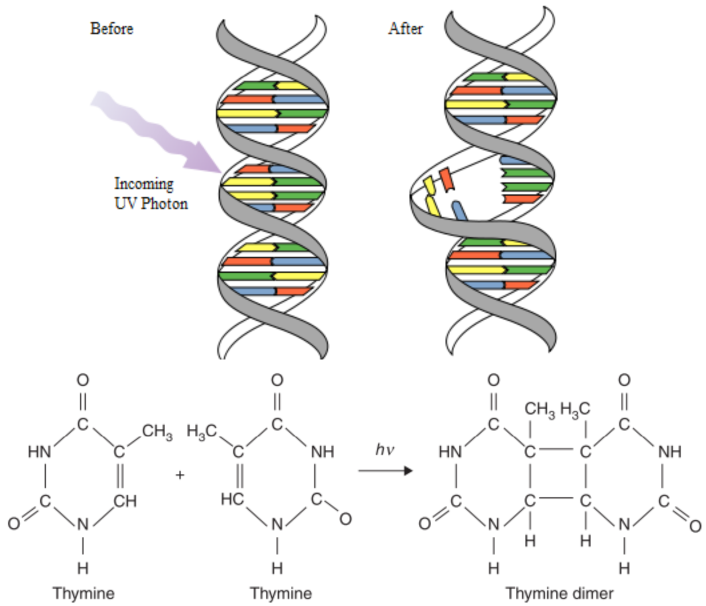


Figure 17.3. Photochemical dimerization of two thymine bases.

Security – fraud detection and forensics

<u>Counterfeit detection:</u>

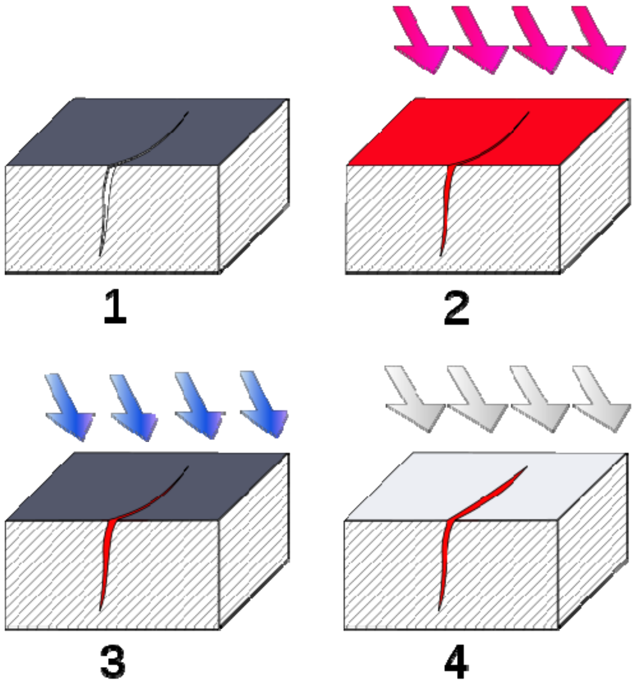
- Authentification of currency, credit cards etc.;
- Longwave UV preferred for safety reasons;
- Efficient UV LED's are desired to integrate with cell phones

<u>Investigation of crime scene/body (forensics):</u>

- Some pepper sprays contain UV pigments;
- Body fluids fluoresce under certain UV-length;
- „Cut-off" googles are used to discriminate evidence from background (i.e. tissues);
- Body fluid fluorescence is highly λ dependent;

Quality control – penetrant testing (PT)

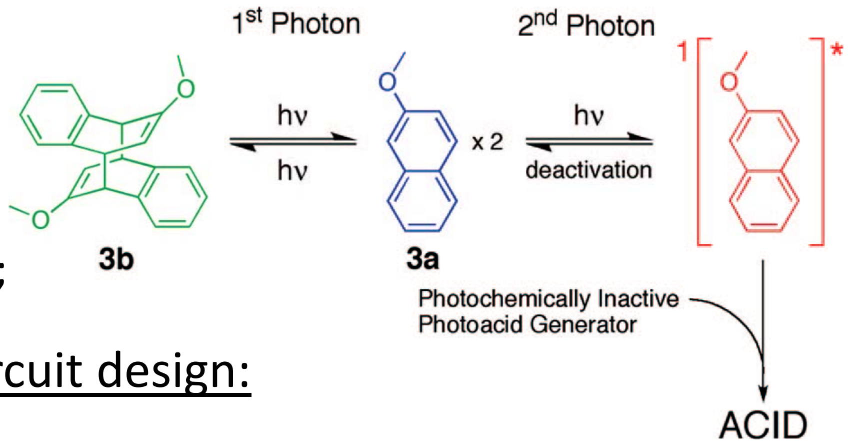
- Reveals surface-breaking defects;
- Low cost;
- Applicable to all non-porous materials;



PT using visible penetrant and developer

PT using fluorescent penetrant under black light

Electronics – circuit design



Photolitography – VLSI circuit design:

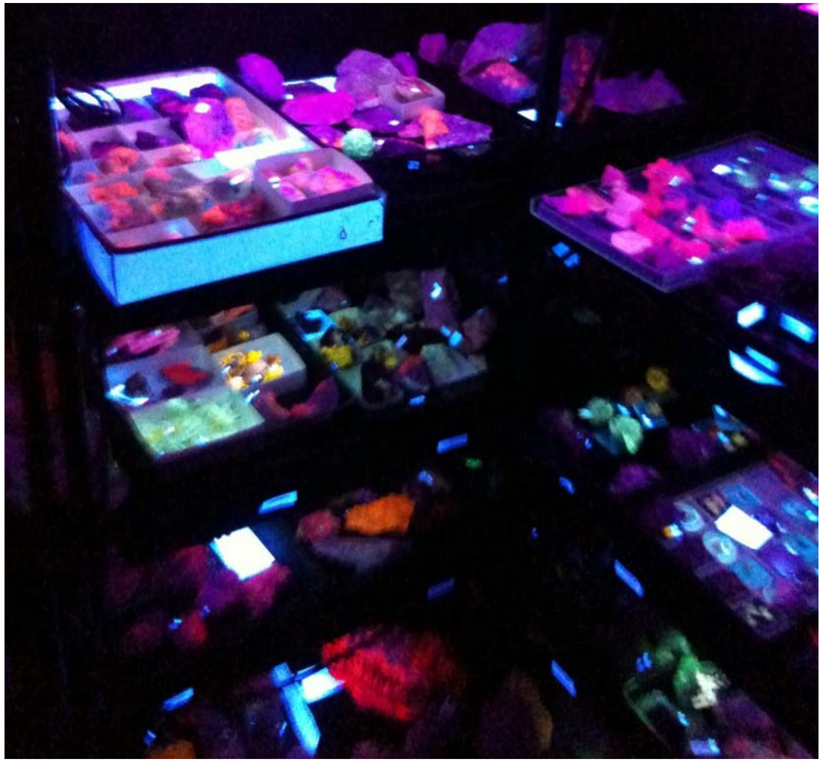
- Exposure to UV changes chemical behaviour of „photoresist” layer;
- Photoresist is etched out with high pH solution;

Photo-CVD using VUV excimer lamps– ULSI circuit design:

- VUV excimer lamps can break almost all bonds in molecules;
- Possible to grow mono-Si on silica substrate and vice versa only by VUV light;
- Typically done by PA-CVD at ~350°C, Photo-CVD uses much lower T;

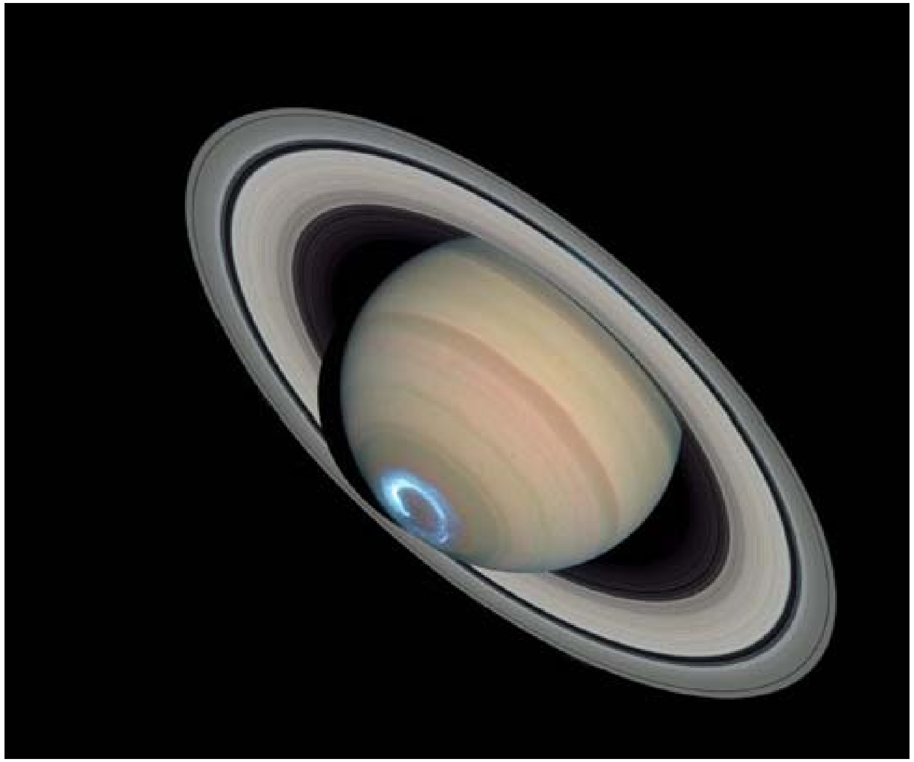
Lamp	Wavelength (nm)	Photon energy (eV)	Intensity (mW/cm^2)
Ar_2	126	9.8	4.2
Kr_2	146	8.5	1.8
Xe_2	172	7.2	10.4
KrCl	222	5.6	6.1
XeCl	308	4.0	7.9

Other applications



Mineralogy

Some gems and minerals fluoresce under UV which is used for gem mining and identification



Astronomy

UV measurements in outerspace reveal very hot objects, depicted aurora on Saturn

Even more „applications”

„Disco blue”

White clothes shine blueish under UV due to the presence of fluorescent dyes absorbed from laundry detergents

„Hot or not” determination

Some spiders are sensitive to UV light. Opposite sexes are attracted to eachother by their fluorescent body parts

References

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