# Types Of laser

## Gas laser

Gas lasers all have in common the same pump source: electricity. The gaseous species enter the excited state either directly, by collision with electrons, or indirectly, by collision with other gases, themselves electrically excited.

Gas lasers cover the whole optical spectrum, from the ultraviolet to the far infrared. However, the spectrum is not continuously covered: gas lasers emit very narrow spectral lines. The most common gas lasers (from the UV to the far IR) include:

- **excimer lasers (ArF:193 nm, KrF:249 nm, XeCl:308 nm)**
- **argon-ion lasers (blue and green wavelengths)**
- **helium-neon lasers (the neon is used for the laser effect) 632.8 nm, 543.3 nm, 1.15 µm, 3.39 µm**

- **$CO_2$ lasers: a large number of wavelengths around 9.6 µm and 10.6 µm.**

Only $CO_2$ lasers are really efficient (15 to 20%). They are used in industry for processing materials. The efficiency of the others is mostly less than 1%. Gas lasers are often bulky and need a great deal of water-cooling (almost all the energy provided by the pump is lost as heat). Even though those operating in the visible (Argon, Helium, Neon) are tending to be replaced by solid state lasers, excimer lasers and $CO_2$ lasers are still very frequently used (for the treatment of materials in the broadest sense).

# Dye Laser

Dye lasers use organic materials that generally emit in the visible spectrum and are thus coloured. These molecules are diluted in a solvent (usually an alcohol, like ethylene glycol or methanol).

The pump source of dye lasers is optical: either an arc lamp or, in the majority of cases, another laser (gas or solid state).

The whole of the visible spectrum is covered. In fact, the dyes are complex organic molecules that have many energy levels. The levels are so close together that they are considered as an energy band. In general, a molecule of dye covers continuously a region of about fifty nanometres in the visible. Dye lasers are the only ones to cover the visible spectrum entirely. Despite these interesting properties, dye lasers are little used because their implementation is impractical: to prevent the molecules from being destroyed by the pump source, the dye circulates in the pumping zone from a reservoir. In addition, the dye and solvent mixture degrades with time and must be changed regularly.

# Solid State Laser

Solid state lasers are either semiconductor (or diode) lasers pumped electrically or those with a crystalline or glass matrix pumped optically. Like diode laser

# Diode lasers

Diode lasers use the recombinations between the “electron-hole” pairs found in the semiconductors to emit light in the form of stimulated emission. The pump source is electrical with an efficiency that can reach 60%. The wavelength can cover from the near UV to the near infrared depending on the materials chosen (GaN, GaAlInP, AlGaAs).

These are the most compact (the cavity uses the cleaved sides of the semiconductor and is barely 1 mm long) and the most efficient lasers available. The power can now reach several kilowatts by putting together hundreds of diode lasers and combining them in the same optic fibre. The only disadvantages of these diode lasers are the poor spatial quality of the emitted beam and that they cannot operate at a pulsed rate

# Other solid state lasers

Other solid state lasers can compensate for the disadvantages of diode lasers. They use matrices that cannot conduct current so cannot be pumped electrically. They are pumped optically by either diode lasers or arc lamps (flash lamps). The matrices are doped with ions whose transitions provide the laser effect ($Nd^{3+}$,$Yb^{3+}$, $Er^{3+}$,$Ti^{3+}$). In general, solid state lasers emit in the red and near infrared. Of particular interest is the wavelength of $Nd^{3+}$:YAG($Y_3Al_5O_{12}$) with an emission at 1064 nm.

Following the host and the ions used, the emission spectra can be narrow (fraction of nm) or wide (undredth of nm). $Tr^{3+}$ : sapphire is one of the material having the largest spectrum : for 700 nm to 1100 nm.

Thanks to non-linear optics, it is possible to convert the wavelength of solid state lasers into the visible and the ultraviolet. In fact, when the electric field intensity is very high, as is the case for laser waves, matter does not respond linearly to the electromagnetic excitation of light. It responds by emitting new frequencies. Figure 23 shows that it is possible to generate new frequencies in a water cell if the laser is intense enough.

# Operational Mode of LASER

(39)

Operational modes of Lasers:-

(1) Continuous Wave / Input source

(2) Pulse mode / Operational source → ON/OFF operational mode

Free Running ← → Q-Switched

↳ Mostly used in Laser, $CO_2$ Laser, Helium Neon

(1) Continuous Wave:-

Source → Electric discharge tube, Optically pumped tungsten filament, Halogen lamps

⇒ The output is always constant with respect to time while input is continous.

↳ It is imp.

⇒ If require short beam than pulsing process is used.

**Q-Switched Operations:-**

Normal shutter is used which is basically involved in cutting source of light during pumping action.

Theory:-

Shutter is ON/OFF system.

when light source on → activate the pumping source → active media store the light when shutter is OFF and light reflect again & again for time nanosec when shutter is ON, its beam become more amplified & reach to detector. It is ON/OFF system.

If shutter close immediatly, band narrow but if shutter close slowly, broad band appears.

• "Q-Switched operations work on ON/OFF ~~system~~ mode."