Emission and Absorption (CA-1130)

Absorption and emission caused by optical pumping is an important process in solid state lasers. Optical pumping causes the inversion of population necessary for laser operation. The pumping efficiency depends on the choice of proper absorption and emission transitions of the active medium. By tuning the temperature of the laser diode chip a wavelength shift and hence the matching of the laser diode emission with the crystal absorption can be optimized.
A laser diode on a thermoelectric cooler is used to pump an Nd:YAG crystal which serves as absorber and emitter at the same time. A laser diode controller allows setting parameters like temperature and current of the pumping diode which defines the diode's emission wavelength. Therefore the spectral absorption profile of the crystal can be traced. The fluorescence of the crystal is collected by suited optics and is selected by a narrow band interference filter transmitting at 1064 nm only. The life time of the excited state is measured by a fast Si-PIN photodiode. Varying the diode current the laser threshold and slope efficiency of the diode laser are determined. A two-channel oscilloscope displaying the measured signals is necessary and can be ordered optionally.

Educational Objectives of Investigation

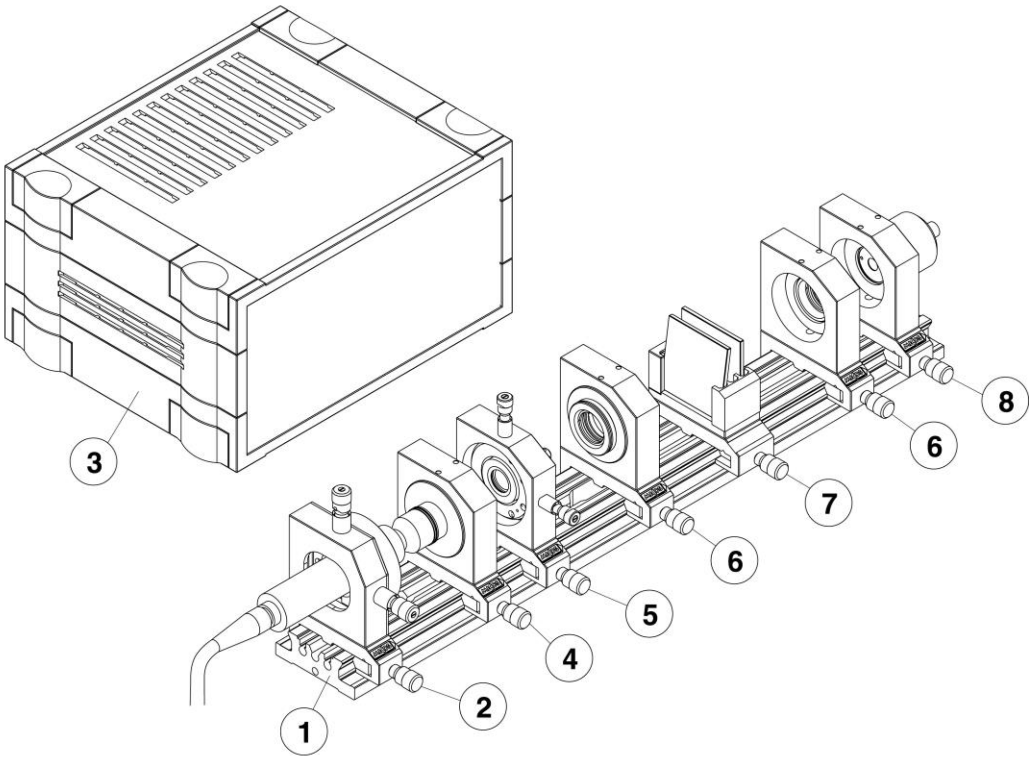
- Einstein Coefficients
- Optical Pumping
- Diode Laser
- Threshold and Slope Efficiency
- Absorption of Nd:YAG Crystal
- Lifetime of Excited States
- Interference Filter
- Longpass Filter

www.e-las.com contact@e-las.com Phone +49 761 2172 4873

Ordering Information

For ordering the Emission and Absorption experimental kit (CA-1130)
use ordering number: 490091130

Setup and Components



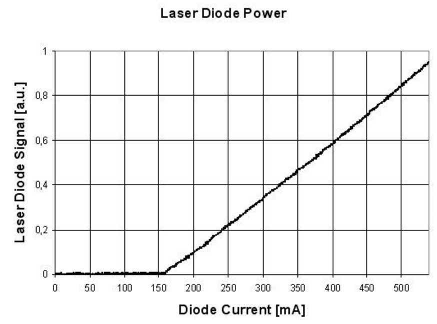
1 Flat rail 500 mm with scale
2 Laser diode 100 mW @ 808 nm, stabilized temperature, in rotating XY adjustment holder on carrier
3 Laser diode controller LDS 1200
4 Beam shaping optics in holder on carrier
5 Nd:YAG crystal in XY adjustment holder on carrier
6 Beam shaping optics for fluorescence light in holder on carrier
7 Filter holder with filter RG1000 and interference filter 1064 nm
8 PIN-photo detector in holder on carrier
9 Set of interconnection cables (not shown)
10 IR-detector card 800-1600 nm (not shown)
11 User manual (not shown)

www.e-las.com contact@e-las.com Phone +49 761 2172 4873

Measurements and Handling

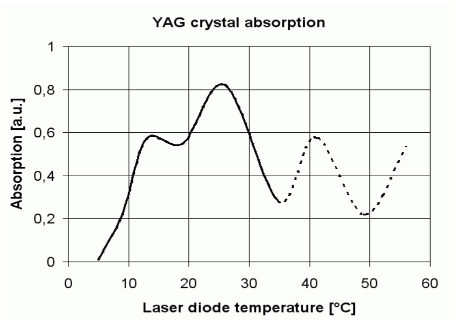
Some of the possible measurements are presented in the following list:

- **Laser diode output power versus current**



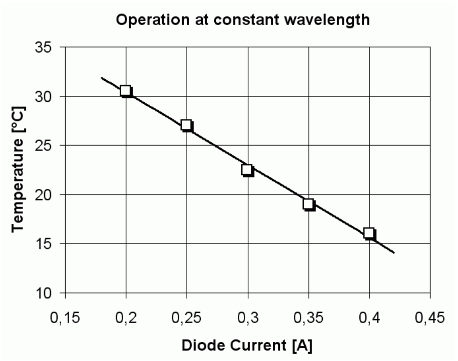
The relative output power of the laser diode can be measured in dependence on the injection current. The laser diode current is either stepwise increased at the settings of the controller, or can be periodically ramped up and down by the internal modulator of the controller. The relative laser power is measured by the photodiode detector, and parameters like laser threshold and slope efficiency are evaluated.

- **Absorption spectrum of Nd:YAG**



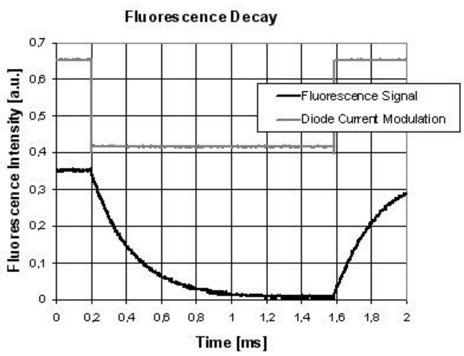
Varying the laser diode temperature changes its emission wavelength. By scanning the laser diode wavelength via temperature change the absorption spectrum of the Nd:YAG crystal is measured. On the other hand, the laser diode emission optically pumps the crystal and causes fluorescence. Filtering the pump light and measuring the fluorescence signal while scanning the diode wavelength allows the measurement of the absorption profile indirectly. The correlation between laser diode temperature and wavelength shift is calculated.

- **Wavelength dependence of injection current**



Increasing of wavelength proportional to raising power is characteristic for laser diodes. To compensate this behavior it is necessary to vary its temperature. Operation at a constant wavelength is realized by working at an absorption minimum (i.e. maximum transmission) and optimization of the temperature and current for maximum transmission.

- **Measurement of life time of fluorescent light**



The Nd:YAG crystal is pumped by the laser diode at around 808 nm. The crystal emits fluorescent light at 1064 nm from the starting level $^4F_{3/2}$. With a filter in front of the detector the pump light is filtered out and the fluorescence can be detected. The current of the laser diode is TTL modulated, and at the falling edge of the signal the fluorescence life time can be measured.

 www.e-las.com contact@e-las.com Phone +49 761 2172 4873