Data sheet microchip MC-1064-150ps

microchip for pulsed laser emission at a wavelength λ = 1064 nm

MC – Microchip

MC-1064-150ps - microchip with 1064 nm laser emission and 150 ps pulse duration

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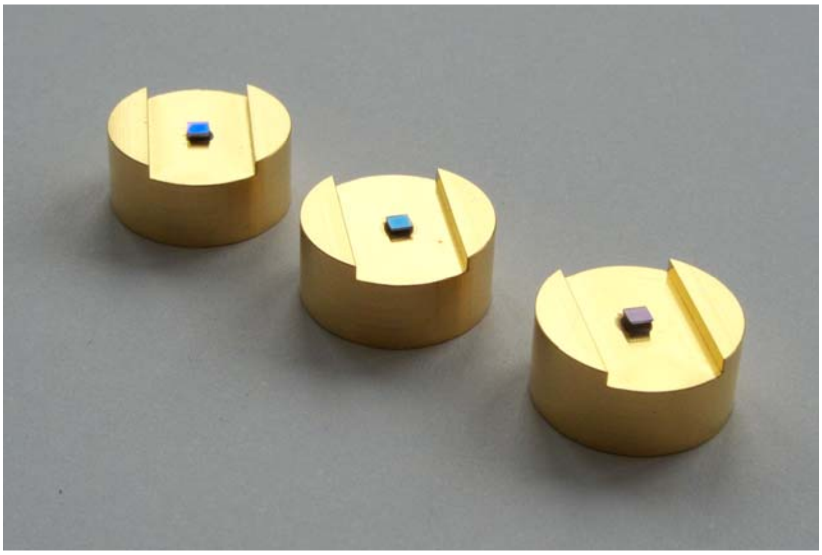
1. Microchip description and applications

The Microchip (MC) consists of a saturable absorber mirror bonded with a Nd:YVO_4 laser crystal. The MC can be used to generate pulsed laser radiation at 1064 nm wavelength if pumped with a pump diode at 808 nm. Possible application areas of this laser radiation are:

- micromachining
- light detection and ranging (LIDAR)
- precision measurements
- frequency conversion

The main advantage of a laser build with this microchip is the pump power dependent repetition rate with fixed pulse duration and pulse energy. By simply increasing the pump power at 808 nm the repetition rate - and consequently the average output power - will be increased proportionally starting from the laser threshold.

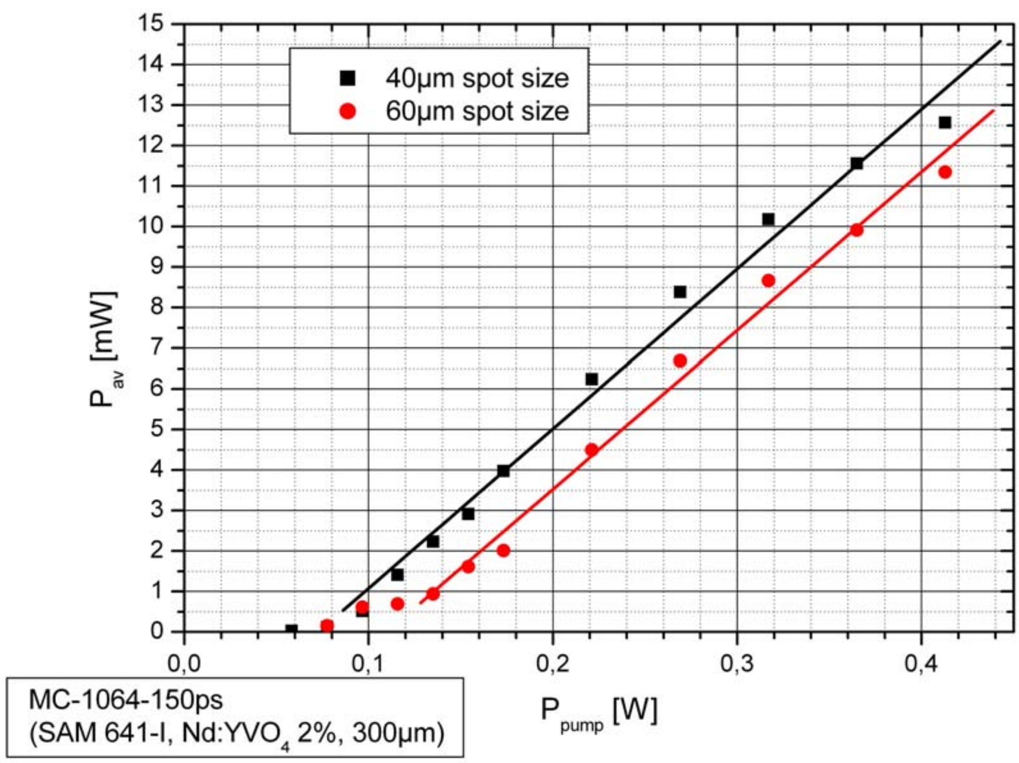


2. Microchip parameters

Laser emission wavelength	λ = 1064 nm
Pump wavelength	λ = 808 nm
Pulse duration	t_P ~ 150 ps
Pulse energy	E_P ~ 10 nJ at 60 µm pump spot diameter
Repetition rate	f_R ~ 100 kHz – 3 MHz, dependent on the pump power density
Average output power	P_{AV} ~ 0.5 – 12 mW, dependent on the pump power
Polarization	linear, perpendicular to the groove in the heat sink
Pump power density	5 kW/cm^2 (threshold) - 55 kW/cm^2 (maximum)
Beam quality	M^2 = 1.05 at 60 µm pump spot diameter
Copper heat sink	12.7 mm diameter, 6 mm thick
	microchip is mounted on the centre in a 1 mm deep groove

The average output power P and the repetition frequency f_R are a function of the optical pump power. These dependencies are nearly linear above the laser threshold. The jitter of the repetition frequency decreases with increasing pump power to about 2 %, whereas the pulse energy E_P remains constant.

Dependency of the average output power P on the pump power at 808 nm



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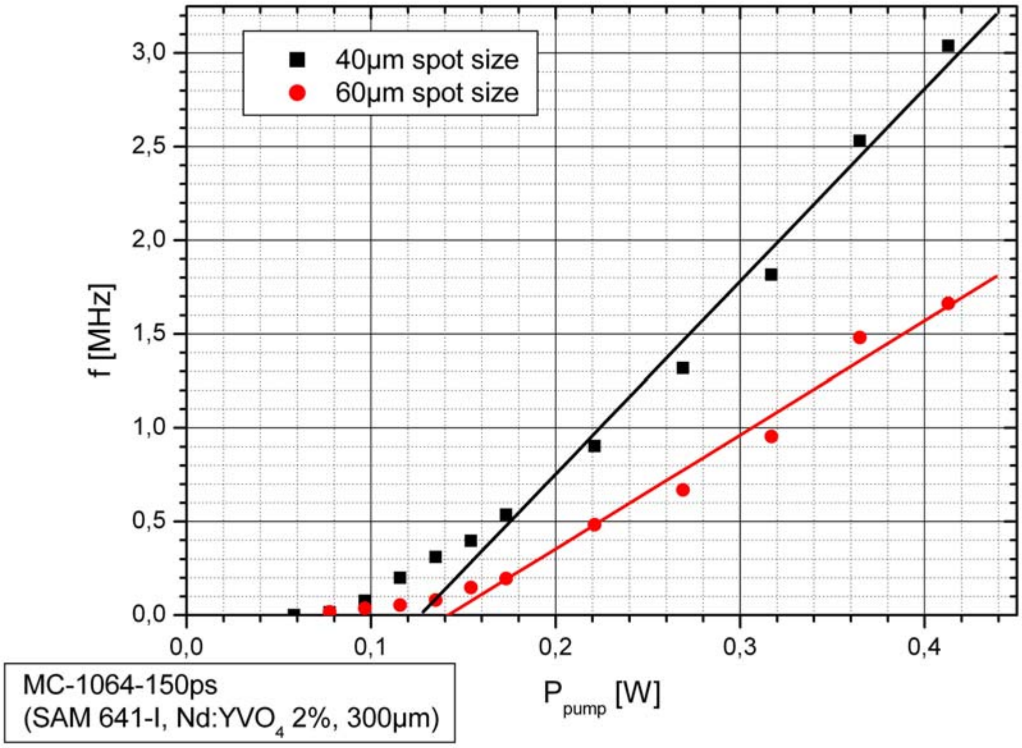
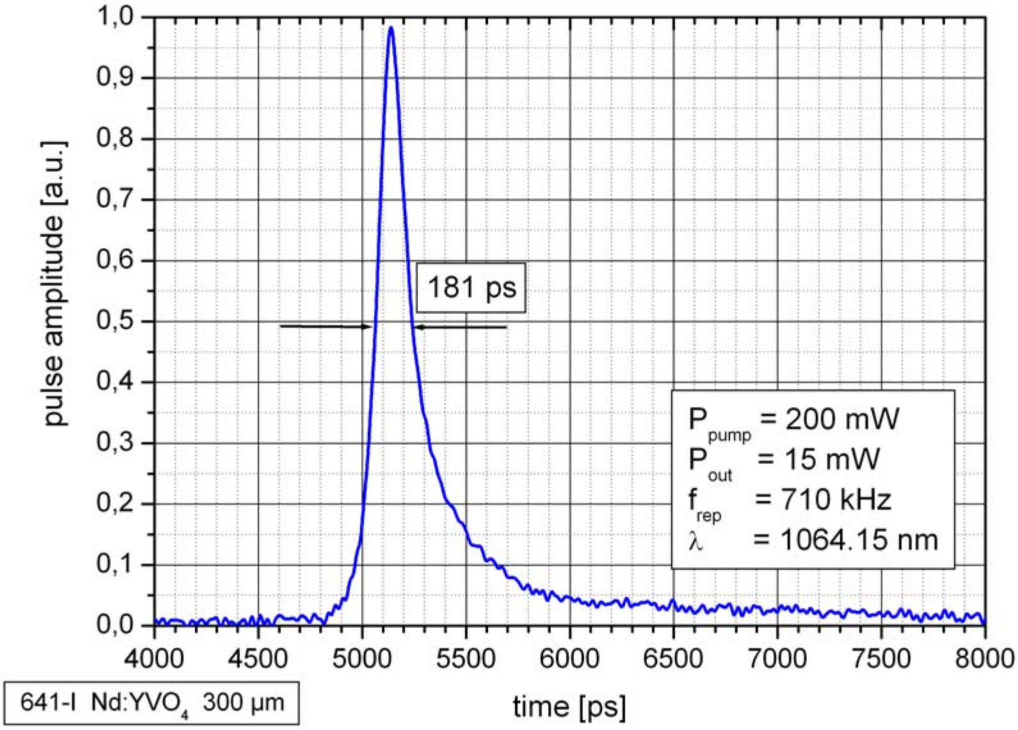
Dependency of the repetition rate f_{rep} on the pump power at 808 nm



Pulse duration

measured by Reinhold Lehneis, Institute of Applied Physics, University of Jena, Germany



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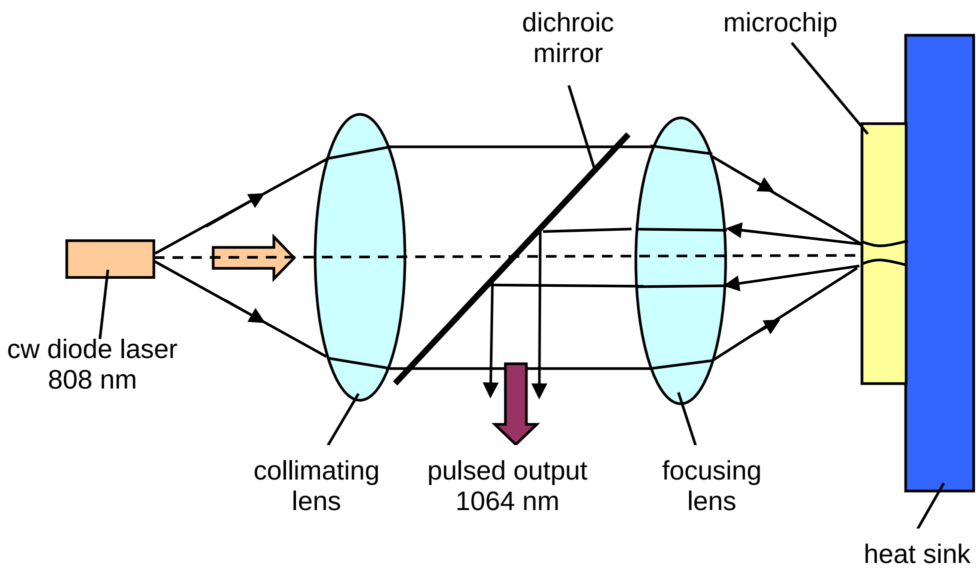
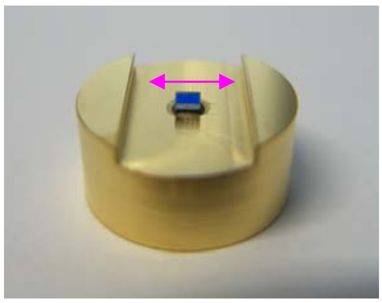
3. Microchip laser setup

The microchip consists of a saturable absorber mirror (SAM) and a Nd:YVO_4 laser crystal. Because the SAM is not transparent, the laser setup must be in reflection mode. For optical pumping a multi-mode laser diode with about 1 W cw output power at 808 nm wavelength is appropriate. The proposed laser setup using two lenses and a dichroic mirror is shown below.



The dichroic mirror has a high reflectance for the laser output at 1064 nm wavelength and a high transmittance for the 808 nm pump light .

The laser output is collimated and nearly diffraction limited, if the pump spot diameter in the laser crystal of the microchip is small enough. Typical pump spot diameter values are between 40 µm and 80 µm.



↔ The arrow shows the polarization direction

4. Theoretical considerations about pulse duration, repetition rate and pulse energy

The pulse energy of a microchip laser can be estimated by[1]

$$E_p \approx F_{sat,L} \cdot A \cdot \Delta R \cdot \frac{T}{T + A_{ns}} \quad , \qquad (1)$$

where $F_{sat,L}$ is the saturation fluence of the laser material, A is the pump spot diameter, ΔR is the modulation depth of the SAM, T is the output loss and A_{ns} denotes intrinsic losses.

The repetition rate f_R is given by[1]

$$f_R = \frac{P_{AV}}{E_p} = \frac{\eta_s \cdot (P_P - P_{P,th})}{E_p} \quad , \qquad (2)$$

here P_{AV} is the average power, P_P is the pump power, $P_{P,th}$ is the pump power threshold and η_s is the slope efficiency (~ 0.5).

The pulse duration can be stated[1] by formula (3) as follows

$$t_p \approx \frac{3.52 \cdot T_R}{\Delta R} \qquad \text{with } T_R = \frac{2 \cdot n_c \cdot d_c}{c} \qquad (3)$$

T_R is the resonator round trip time which comprises the refractive index n_c and the thickness d_c of the laser crystal. For a deeper theoretical review please see [2].

[1] Appl. Phys. B 97 (2009) p.317-320, A. Steinmetz et. al., “2 MHz repetition rate, 200 ps pulse duration from a monolithic, passively Q-switched microchip laser”

[2] J. Opt. Soc. Am. B Vol. 16 (1999) p.376-388, G. J. Spühler et. al., “Experimentally confirmed design guidelines for passively Q-switched microchip lasers using semiconductor saturable absorbers”