CW gray-track formation in KTP

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Outline

- Pulsed and CW tracks in KTP
- Photothermal technique
- Double-track build-up
- Model
- Conclusions
‘Pulsed’ and ‘CW’ tracks in KTP

- Different types of ‘gray tracks’, Scripsick and Ruland (1998):
  - Laser induced photochromic damage at high peak power
  - Laser induced electrochromic damage at high average power, high repetition rate
  - Unidentified laser induced damage at high average power, high repetition rate

- We studied CW, high average power case:
  - \( \lambda = 514 \text{ nm} \)
  - Power: up to 1.5 W
  - Spot diameter: 70 \( \mu \text{m} \)
  - Maximum power density of 40 kW/cm\(^2\)
The technique used in this work is a modification of the thermal lensing technique. The technique has the interferometric sensitivity: less than 1\(\mu\)W of absorbed power can be detected.

Crossed-beam setup for the measurement of a weak absorption. PL: projecting lens, PD: photodetector. Second pump is added whenever the influence of light with a different wavelength on absorption of the first pump is to be studied.
Gray track detection: details

- Two collinear, centered pumps: IR 1064 nm and green 514 nm
- Slightly smaller IR spot to see what happens inside the green beam
- Green beam builds gray track
- Gray track spectrum reaches near IR: its development can be monitored at 1064 nm
Double-track build-up: initial stage

Absorption at 1064 nm:
response for 30 kW/cm² of CW green applied for 10 sec

- Orders of magnitude different response in different crystals
- Fast and slow components
- Track is within green beam region yet
Double-track build-up: developed stage

30 kW/cm² of CW green applied for 15 min

- Initially comparable responses may proceed differently
- After a certain time absorption in the green beam region reaches maximum and starts to drop
- Outside the green beam region double-track appears and proceeds to grow
**Double-track profile**

IR track profile: strong track

- High peak from the +Z side of the green beam
- Lower peak from the -Z side
- 120 microns between peaks with a green spot of 70 microns
Double-track profile

Green profile: strong track

- Peaks are comparable in height
- Location of peaks the same as for IR
Model

Laser induced electrochromic damage: electrolysis in the green beam region initiated by a photogalvanic current

\[ j_e = \sigma_e E + (kI) \]
\[ j_i = \sigma_i E \]

\[ j_e + j_i = 0 \]
\[ E = -\frac{kI}{\sigma_e + \sigma_i} \]
\[ E \approx -\frac{kI}{\sigma_i} \rightarrow 0 \]
\[ j_i = -kI \]

- KTP is known as an ionic conductor
- Rapid, within minutes, drift of the absorption maximum on the +Z side of green beam further in the +Z direction when the green pump is shifted in this direction
- Less gray-tracking corresponded with apparently high-resistivity KTP
- Photorefrraction was directly observed in RTP and high-resistivity KTP
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Conclusions

- CW track in KTP looks like this
- Photogalvanic effect + ionic conductivity build double-track
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