Experiment No.( 2 )
Laser Diode End Pumped Nd :YVO₄ Laser

**Aim of experiment:**

A. Study how the reflectivity of the output coupler will affect on the cavity loss.
B. Understand how the cavity length effect on the cavity loss by change cavity loss with fixed coupling loss.

**Apparatus:**

1-Laser current driver, 2-aiming on optical plate 3-several output coupler mirror, 4-HR coating or 1064nm, 5-IR sensor card, 6-power meter device.

**Theory:**

Nd³⁺ doped yttrium orthovanadate (YVO₄) has shown a relatively low threshold at pulsed operation, early studies of this crystal were hampered by severe crystal growth problems, and as a result YVO₄ was discarded as a host. With the emergence of diode pumping, Nd :YVO₄ has become an important solid-state.

A diode-end pumped solid-state laser (DPSSL) especially single-end-pump solid-state laser with high efficiency, high output power, a good spatial beam profile, and good stability is highly desired for use in material processing and other scientific applications such as pumping other laser crystals.

Laser diode pumping has numerous advantage compared to lamp pumping including:

- Matching the laser diode emission with the absorption bands of gain medium.
- Easy to match laser diode beam profile to the fundamental laser resonator mode volume in the gain medium.
- Laser diode has high efficiency more than 30% for high power and 85% for low power.
- Lifetimes are quit high more than 5,000 hours.
- Cooling system is very easy heat sink only.
- Low cost, weight, and other advantage.

The Nd :YVO₄ crystal was identified as a promising gain medium because of its many advantages such as a high absorption over a wide pump-wavelength bandwidth, a large efficient stimulated emission cross-
section, a high allowed doping level and a polarized output, it has been used in high-power DPSSL more and more.

Compared with Nd:YAG and Nd:YLF for diode laser pumping, Nd:YVO₄ lasers possess the advantages of lower dependency on pump wavelength and temperature control of a diode laser, wide absorption band, higher slope efficiency, lower lasing threshold, linearly polarized emission and single-mode output.

**Procedure:**

- Relation between reflectivity of o/p coupler and laser o/p
  1. Insert the o/p coupler to short cavity position.
  2. Switch on the laser aiming kit, find out the red spot of the output coupler.
  3. Adjust the angle of the coupler to align the red spot to the light source of the aiming kit.
  4. Switch on the power supply to (1000 mA), use the IR card to check whether the laser o/p is ready.
  5. Then fine tune the o/p coupler to achieve TEM00 mode or max power o/p.
  6. Use the power meter device to measure the laser power o/p.
  7. Decrease the current, use the IR card sensor to measure the electric current where the laser is just emitted, that figure will be the threshold current $I_{th}$.
  8. Record the IR laser o/p under different electric & plots the $I$-$P$ graph.
  9. Alter the reflectivity of the o/p coupler, then repeat above step.

**Calculation:**

1. Complete the following tables:
   R1 = 95%
   
<table>
<thead>
<tr>
<th>I (A)</th>
<th>$P_o$ (mW)</th>
<th>$I_{th}$ (A)</th>
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   Table (1)

R2 = 90%

<table>
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<tr>
<th>I (A)</th>
<th>$P_o$ (mW)</th>
<th>$I_{th}$</th>
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   Table (2)
R3 = 80%

<table>
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<th>I (A)</th>
<th>P (mW)</th>
<th>Ith (A)</th>
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Table (3)

R4 = 70%

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<th>I (A)</th>
<th>P (mW)</th>
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Table (4)

**Discussion:**

1. Discuss the I-P graph and Ith graph?
2. Compare the end pumped with the side pumped?
3. Give characteristics of mirrors (rear & coupler) for DPSSL.