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Nizhny Novgorod, Russia, 4.12.12 - 7.12.12

Optical Properties and laser performance of Ho:LuAG laser ceramics

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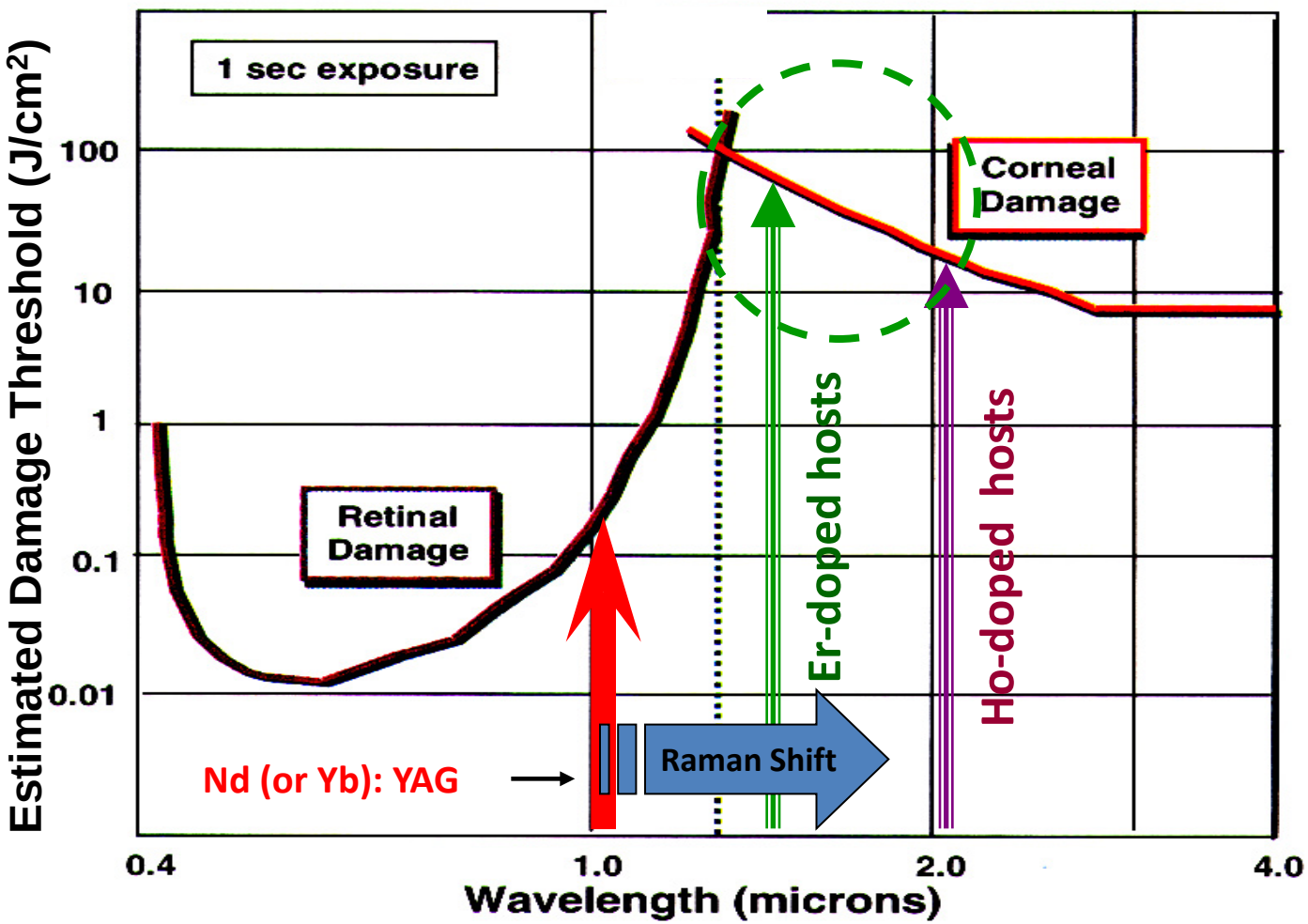
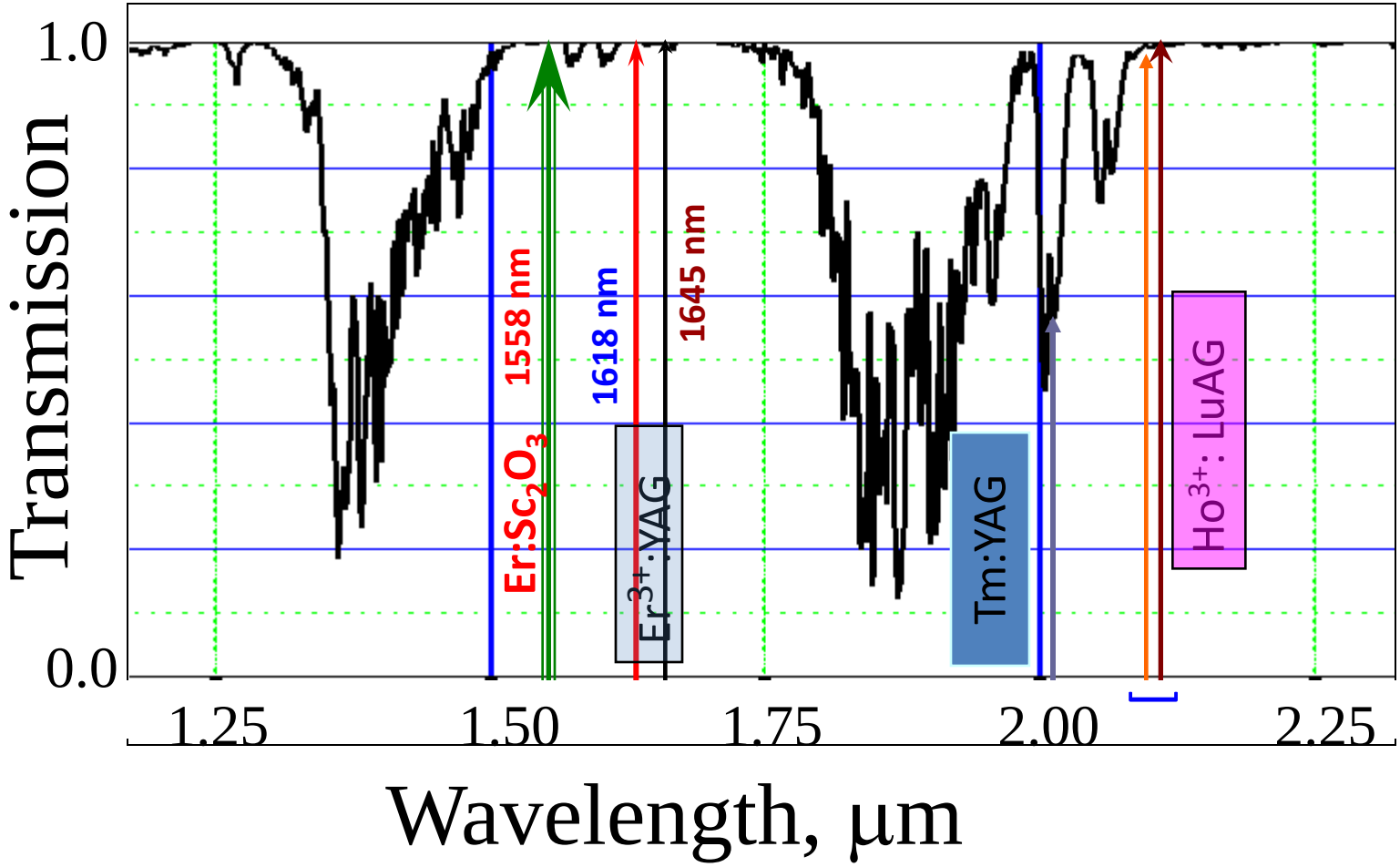
Outline

- Introduction
- Fabrication Process
- Results for Ho:LuAG
- Summary

Eye-Safety Issue



Atmospheric Transmission



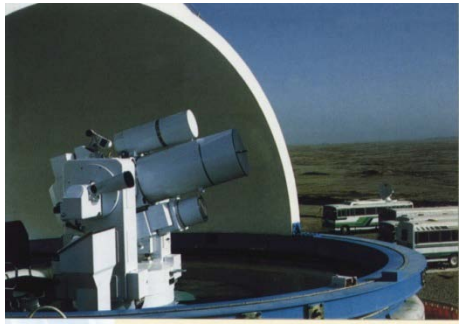
Data obtained from the UKIRT (United Kingdom Infra-Red Telescope), Hilo, Hawaii; Altitude: 4200m, path - horizontal

Mid-IR Laser Application

Laser radar

Laser guide

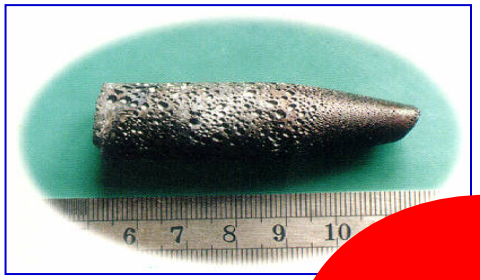
Medical machine



Remote sensing

Laser weapon

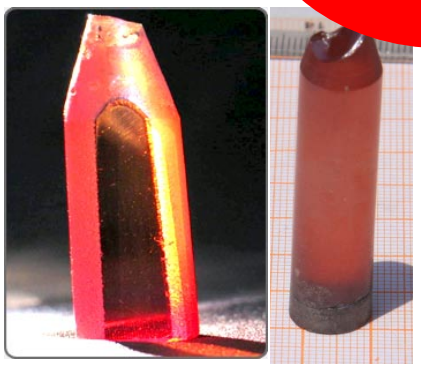
Mid-IR Laser Materials



$AgGaSe_2$

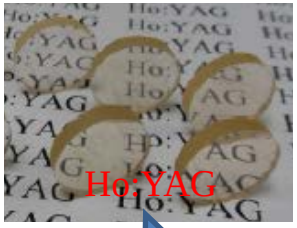
$ZnGeP_2$

Nonlinear crystal

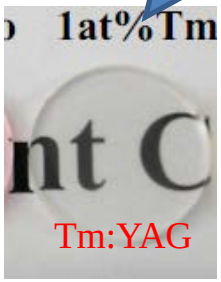


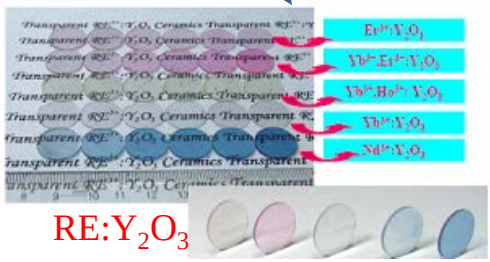
$LiInS_2$

The problem for IR NLO crystals :
Low damage threshold

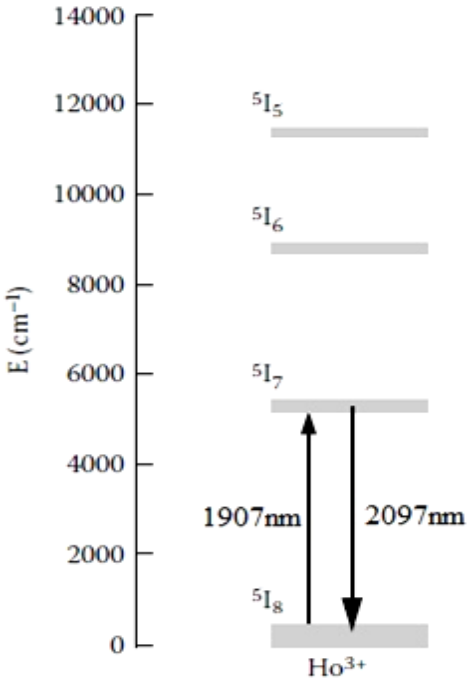


Laser ceramics





Mid-IR Laser Materials

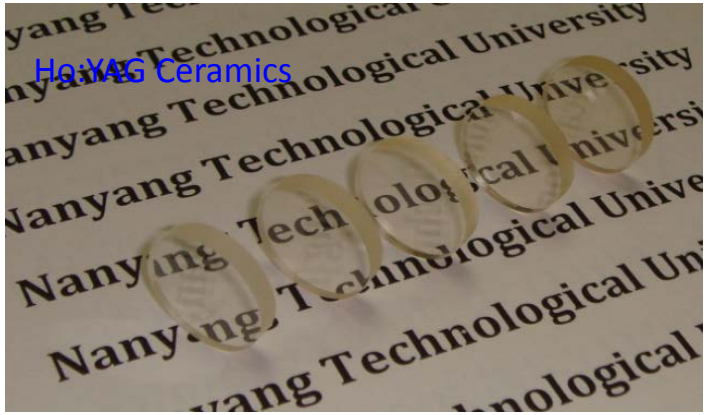


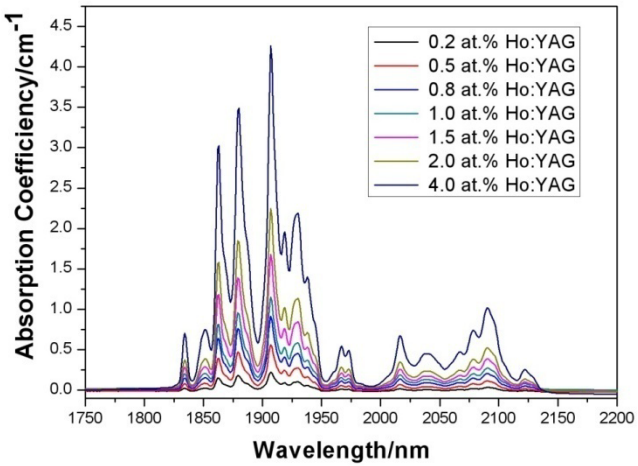
	YAG	LuAG
Density	4.55g/cm^3	6.72 g/cm^3
thermal conductivity	10.5w/m·K	9.6 w/m·K
Lattice constant	12.0075Å	11.9164Å
Crystal structure	Cubic	Cubic

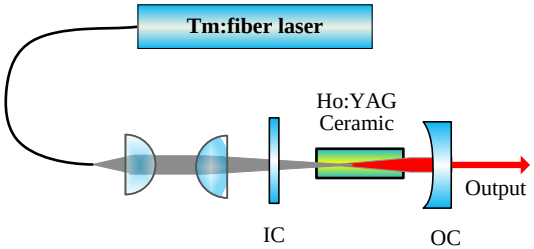
Ho^{3+} is suitable for producing ~2.0μm laser arising from the $^5I_7 \rightarrow {}^5I_8$

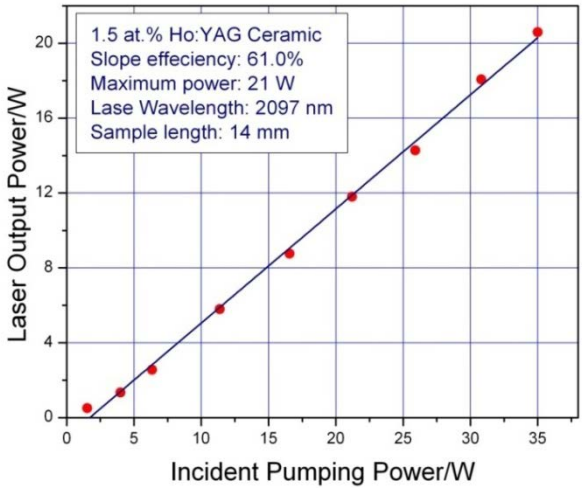
Compared with YAG, LuAG possess higher density, higher crystal field, leading to large Manifold splitting and low thermal occupation for the lower laser level

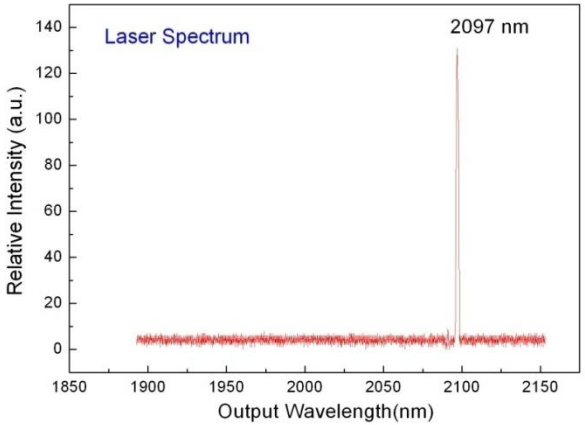
Ho:YAG ceramic laser







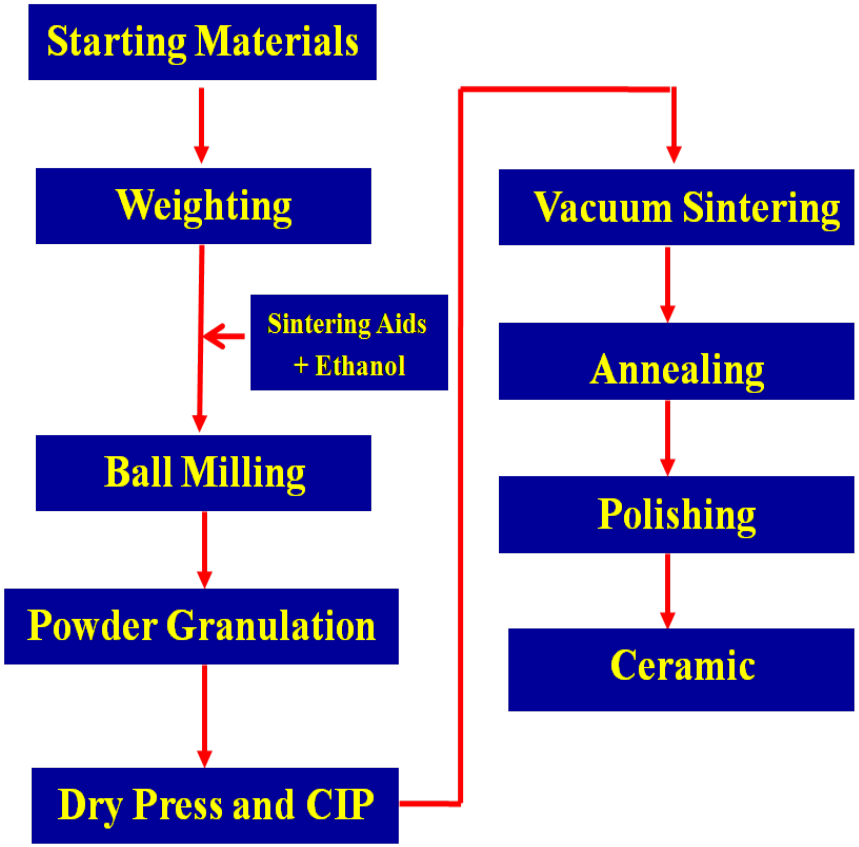




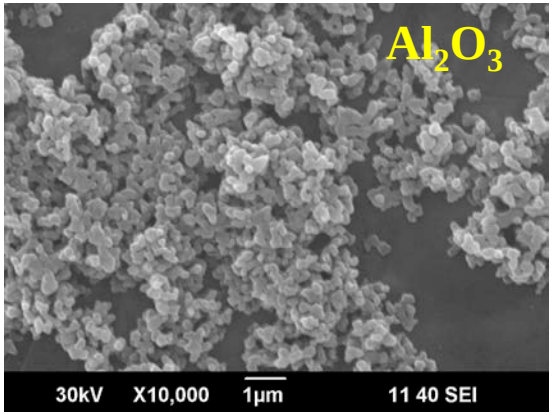
- ❖1907 nm Tm:fiber was used as the puming source
- ❖ Max power: 21 W、2097 nm
- ❖Slope efficiency: 61%

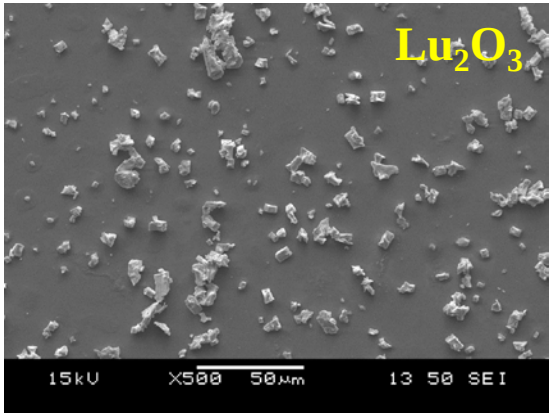
H.Chen, D.Y. Shen, J. Zhang, H. Yang, et al, Optics Letters, 36:1575-1577, 2011
H. Yang, J. Zhang, X.P. Qin, D.Y. Shen, J. Am. Ceram. Soc., accepted for publishing, 2012

Fabrication Process



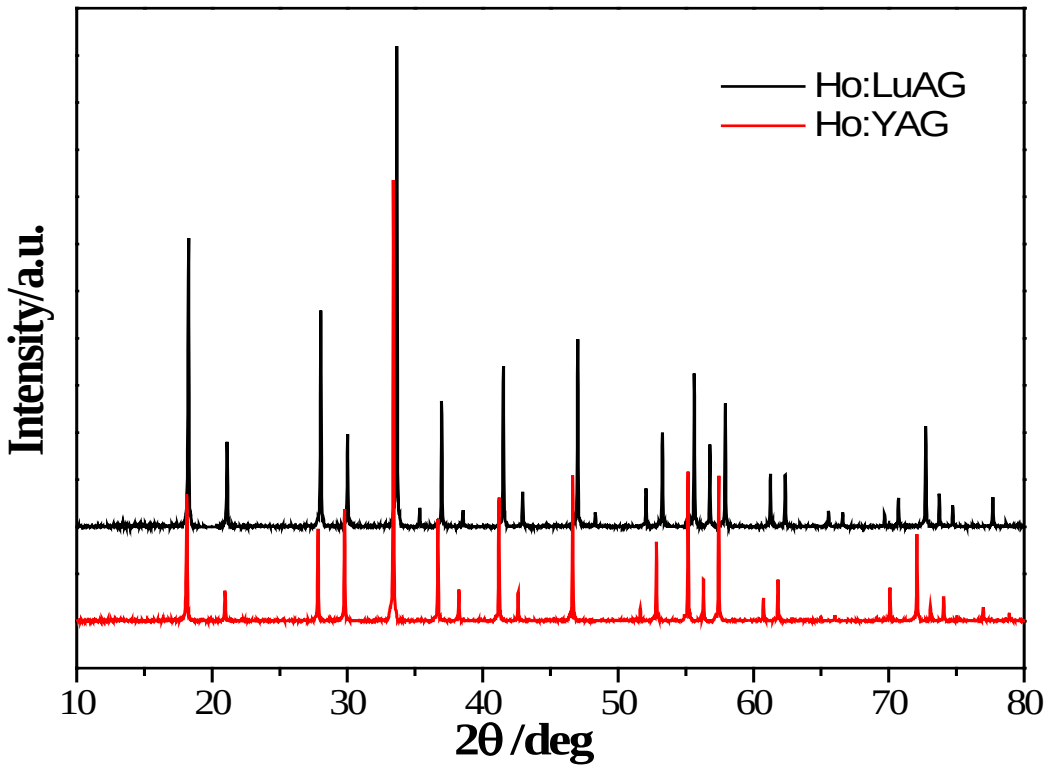
Reactive sintering method





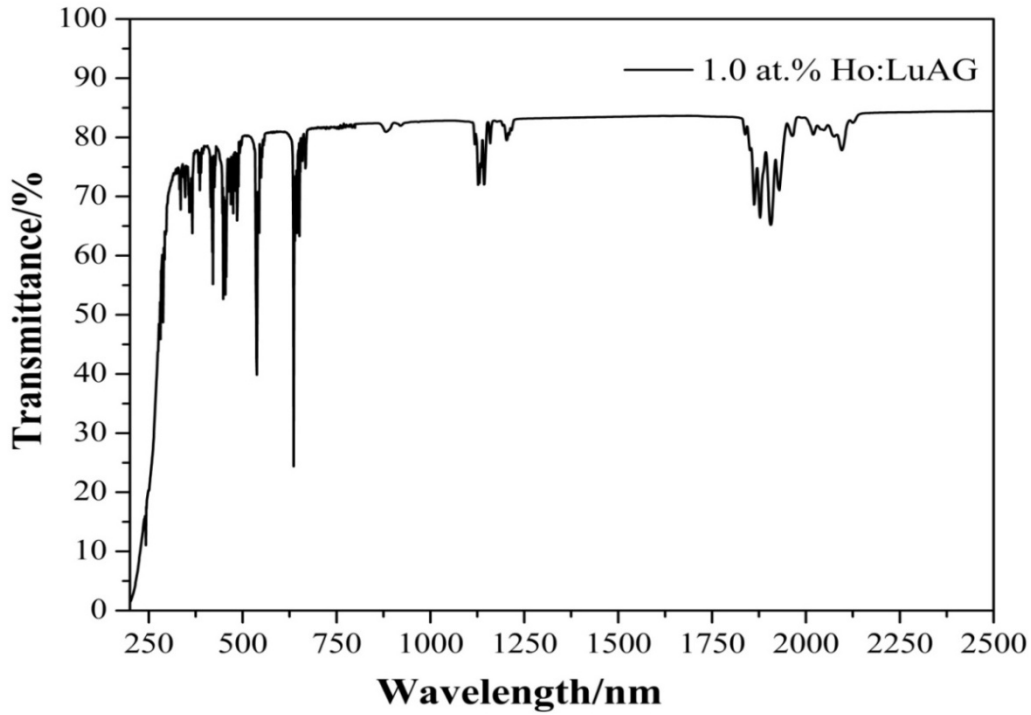
SEM of commercial powders

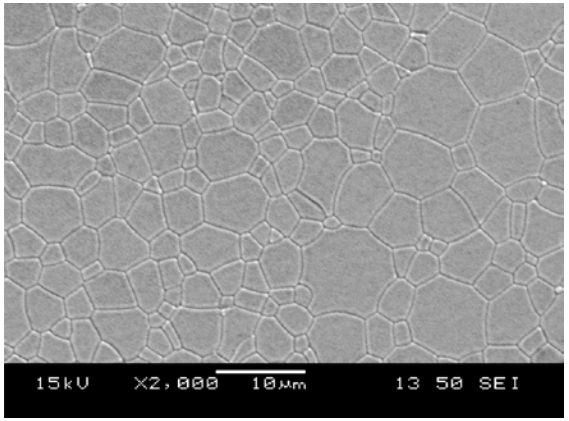
XRD Patterns

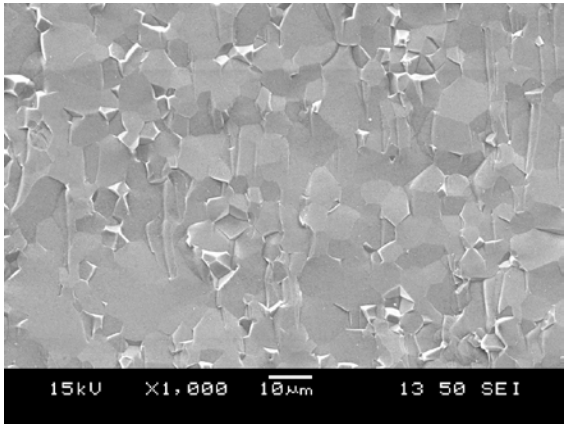


The peaks of the Ho:YAG and Ho:LuAG ceramics are well indexed as the cubic YAG and LuAG structure. And the lattice constant of LuAG is smaller than that of YAG.

Optical properties and microstructure





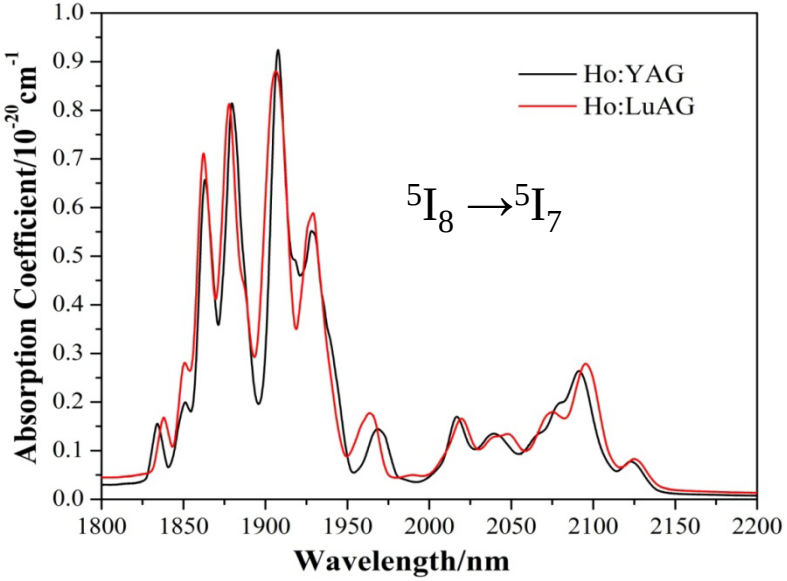


Ho:LuAG transparent ceramics owned great optical property. The in-line transmittance was higher than 84% at 2500 nm.

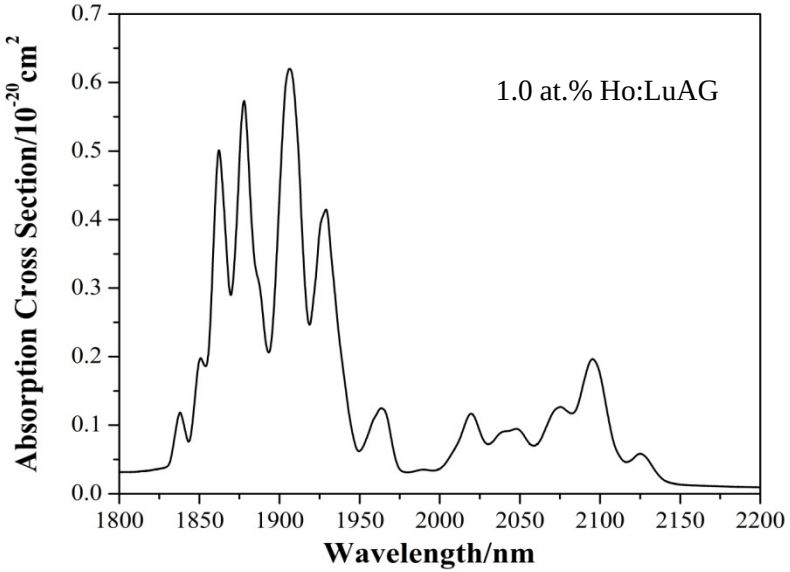
Average grain size is ~10μm

Absorption spectrum

1.0 at.%Ho



Absorption cross section spectrum

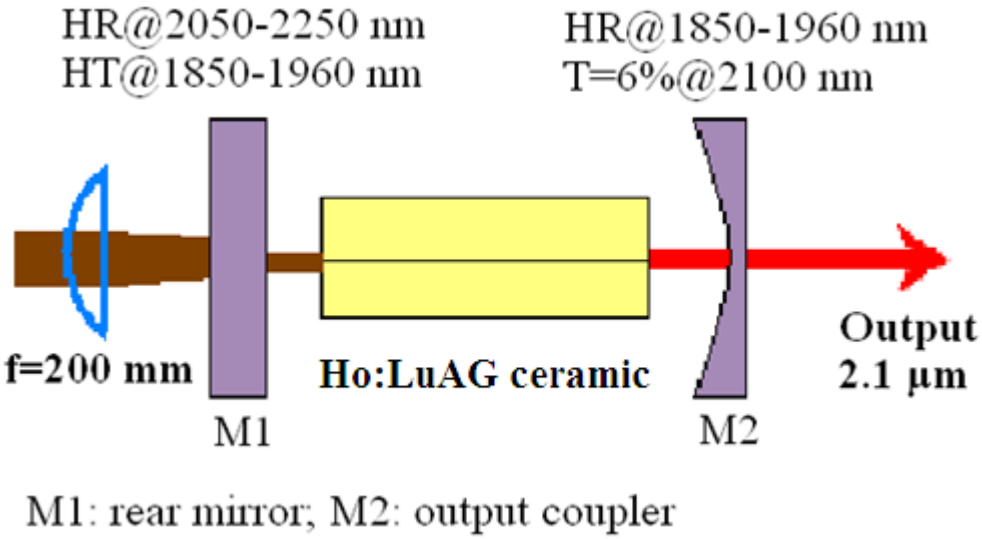


Absorption coefficient@1906 nm:
Ho:YAG 0.89 cm^{-1}
Ho:LuAG 0.88 cm^{-1}

0.62×10^{-20} cm^2 @ 1906 nm

Laser test on Ho:LuAG

1.0 at.% Ho:LuAG



Schematic of Ho:LuAG ceramic laser test

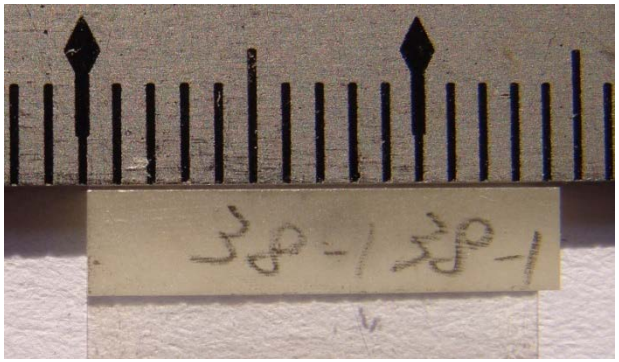
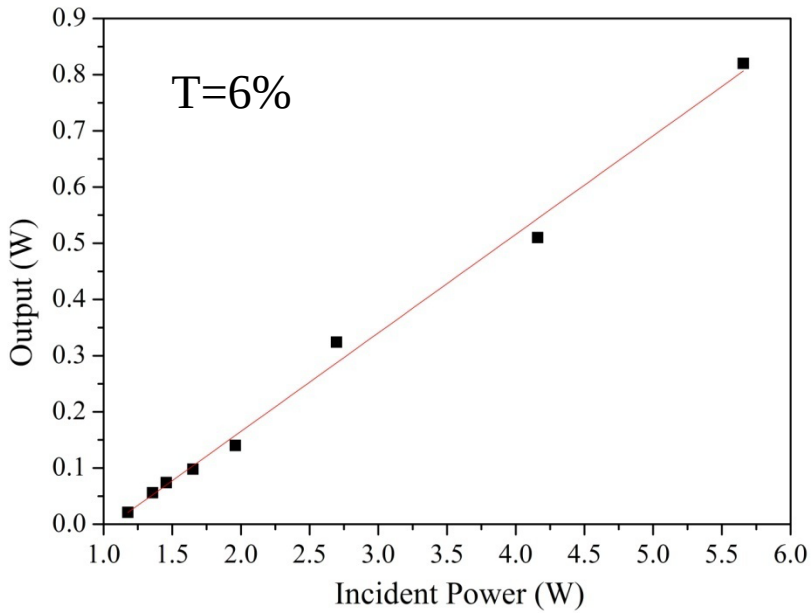
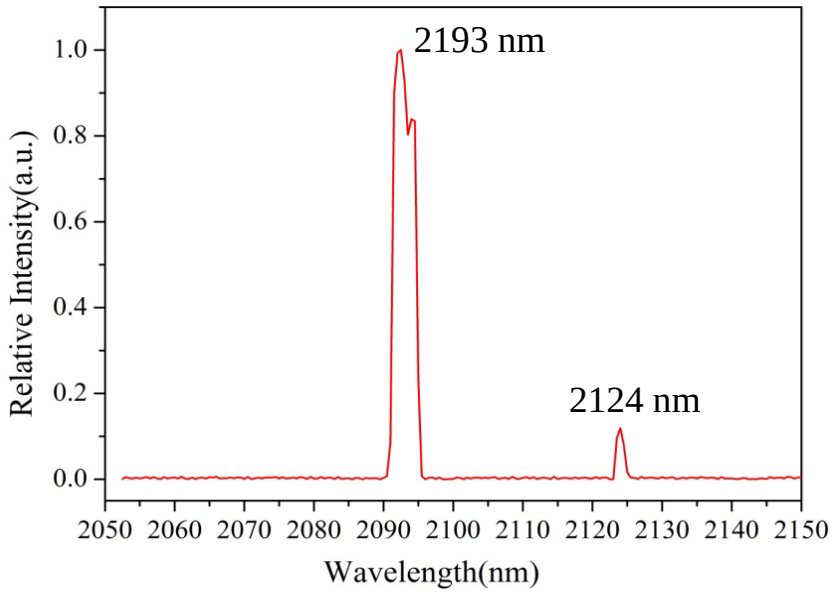


Photo of the ceramic

Laser result on Ho:LuAG

1.0 at.% Ho:LuAG





Slop efficiency: 17.5%

Double output laser

Summary and future work

- Ho:LuAG laser ceramics have been fabricated
- Ho:LuAG ceramic laser was achieved successfully
- The quality can be improved better

Thanks for your attention!