LASER EMISSION AND SPECTROSCOPIC CHARACTERIZATION OF Yb:$(Y,Sc)_2O_3$ CERAMICS

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We demonstrated for the first time efficient laser action in a $(Yb_{0.058}Sc_{0.508}Y_{0.434})_2O_3$ mixed ceramics fabricated by vacuum sintering of laser ablated nanopowder, with an output power of 5 W at 1086 and slope efficiency 61.3%.
Keywords: Laser ceramics, Yb:$(Y,Sc)_2O_3$

1. Introduction

In the last years crystals and polycrystalline ceramics based on Yb doped mixed sesquioxides (e.g. Yb:$(Y,Lu)_2O_3$ [1], Yb:$(Lu,Sc)_2O_3$ [2]) have attracted a strong interest. The mixed structure results in a disordered lattice structure that can induce a inhomogeneous broadening of the emission band, making these material more attractive for laser applications (e.g. broadband tuning, generation of ultrashort pulses) than the pure compositions. Here we report on the spectroscopy and the high efficiency laser emission performances of a new mixed Yb:$(Sc,Y)_2O_3$ ceramics.

2. Fabrication technique and experimental setup

The samples were fabricated at the Institute of Electrophysics (Russia) starting from nanopowders produced by laser ablation technique with the desired Y/Sc/Yb ratio. The powders were uniaxially pressed and then sintered in vacuum (1780°C, 20 h). The chemical composition, morphology and lattice structure of the ceramics were carefully analyzed.
The impact of the different Sc/Y balances of the spectroscopic properties of Yb was carefully analyzed by means of absorption and emission spectroscopy and by the measurement of the lifetime of the upper laser level. The laser properties were characterized under high power semiconductor laser pumping at 929.4 nm in *quasi*-CW regime, using an end-pumped, V-shaped cavity. The laser emission tuning properties were also investigated.

3. Results and Discussion

The absorption and the emission spectra of the samples were found significantly affected by the ratio Y/Sc in the composition, with a significant broadening. As for the laser emission properties, several output coupler mirrors were used to optimize the power exctraction efficiency. As a result a maximum output power of 5 W was obtained at 1088 nm with an absorbed pump power of ~ 9 W, whereas the maximum slope efficiency was 61.3%.

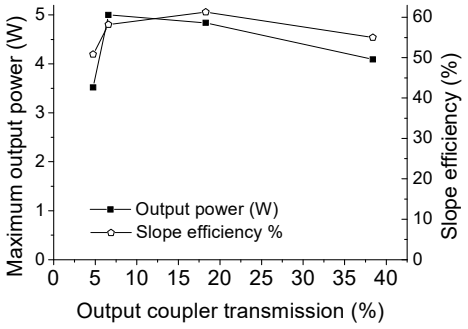

Fig. 1 Laser maximum output power and slope efficiency obtained with output couplers with increasing transmission.

7. Conclusion

We have investigated the spectroscopic and laser behavior of $(Yb_{0.058}Sc_{0.508}Y_{0.434})_2O_3$ ceramics. The material has shown excellent laser efficiency properties and a broad emission tuning range This is the first time that laser action of a Yb:$(Sc,Y)_2O_3$ ceramic is achieved.

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References

1. G. Toci et al., Opt. Mater. **83**, 182-186 (2018)
2. K. Beil et al., Appl. Phys. B **113,** 13-18 (2013)