PASSIVELY Q-SWITCHED, COMPOSITE, ALL-POLY-CRYSTALLINE CERAMICS Nd:YAG/Cr^{4+}:YAG LASER

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The passive Q-switching technique yields laser pulses that are of great interest for scientific, medical and industrial applications that do not require temporal accuracy better than microseconds range. This method provides lower output performances compared to electro-optic or acousto-optic Q-switched lasers, but presents various advantages, such us simply design, good efficiency and reliability, compactness, or low cost. Most of the previous developed Nd:YAG/Cr^{4+}:YAG lasers were made of single-crystals components [1]. Nowadays, the advancement in ceramics techniques has reached a maturity stage, especially in obtaining poly-crystalline cubic laser media of very good optical quality. It is then recognized that laser ceramics is an alternative to the crystalline optics, especially due to an easier manufacturability and lower price. To date there are only few reports on Q-switched emission of Nd:YAG/Cr^{4+}:YAG [2] or Yb:YAG/Cr^{4+}:YAG [3] ceramics lasers, with laser pulses of low (few hundreds of μJ) energy at high (few kHz) repetition rate. In this work we report laser performances obtained from passively Q-switched, Nd:YAG/Cr^{4+}:YAG media that were made of all-poly-crystalline Nd:YAG and Cr^{4+}:YAG ceramics bonded together.

Two composite, all-poly-crystalline ceramics Nd:YAG/Cr^{4+}:YAG media were prepared for experiments by diffusion bonding at elevated temperature (Baikowski Japan Co., Ltd.). The first medium consisted of a 1.1-at.% Nd:YAG ceramics that was bonded to a Cr^{4+}:YAG SA ceramics with initial transmission T_0= 0.30. The total length of this ceramics was 9.5 mm. The second, 7.5-mm thick Nd:YAG/Cr^{4+}:YAG ceramics consisted of an 1.5-at.% highly-doped Nd:YAG and a Cr^{4+}:YAG SA as described before. The Nd:YAG surface acted as the rear mirror of the laser and the out-coupling mirror was coated on the free surface of Cr^{4+}:YAG. Green laser pulses at 532 nm were obtained by single-pass second harmonic generation in a LiB_3O_5 nonlinear crystal (type I phase matching, 25^{o}C room temperature).

The influence of pump-beam spot size on laser pulse performances was investigated, and a theoretical model was used to explain the experimental results. Laser pulses at 1.06 μm with 2.5-mJ energy and 1.9-MW peak power were obtained from the 1.1-at.% Nd:YAG/Cr^{4+}:YAG ceramics. Single-pass frequency doubling yielded green laser pulses of 0.36-mJ energy and 0.3-MW peak power, with a conversion efficiency of 0.27. Such a system offers a solution for realizing high-peak power laser pulses into visible and ultraviolet regions by single-pass nonlinear conversion.

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References

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