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Co^{2+}:$MgAl_2O_3$ Crystal Passive Q-Switch Performance At 1.34, 1.44 and 1.54 micron

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Abstract:

Cobalt doped materials, such as Co^{2+}:ZnSe, Co^{2+}:YSGG, and Co^{2+}:$MgAl_2O_3$, have shown promise for use as high performance saturable absorber Q-switches for near infrared lasers. A good saturable absorber should exhibit relatively long excited-state lifetimes and a large absorption cross section. Divalent cobalt exhibits a large absorption cross section and extensive variations in excited-state lifetime when doped into different host materials.

The broad absorption band produced by Co^{2+}:$MgAl_2O_3$ (also known as cobalt doped spinel or magnesium aluminate) in the 1.3 to 1.5 micron region is due to the $4A_2$ to $4T_1$ transition. In this paper we report on the performance of Co^{2+}:$MgAl_2O_3$ as a passive q-switch at 1.54, 1.44, and 1.34 micron.

A 1 mm thick Co^{2+}:$MgAl_2O_3$ sample with ~ 92%T @ 1.54um was evaluated in a diode pumped QX/Er Erbium glass laser resonator. The Cutting Edge Optronics water cooled pump chamber contains 30 (25W) 940nm diode arrays. Five sets of linear six bar units side pump a QX/Er laser rod in pentagon shaped configuration and provide 6.5 cm of gain length. This pentagon head produces up to 750 watts of peak pump power with pump pulsewidths up to 5ms. The laser produced TEMoo mode 1.54um laser output pulses of 6.5 mj with a 35ns pulsewidth at 1Hz. The ratio of long pulse energy to Q-switched pulse energy is about 6.3. Multi-mode output pulses of 20mj, 35ns were demonstrated at 20Hz repetition rate. The Q-Switched output spatial mode profiles produce "beautiful" sharply defined multi-mode patterns. Our test results indicate that Co^{2+}:$MgAl_2O_3$ exhibits better 1.54um passive Q-switch performance than U^{4+}:CaF_2.

A flashlamp pumped Nd:YAG laser resonator with a 6 x 100mm rod and a 80% output coupler was operated at 1.44 um. Q-switching was accomplished with a plate of Co^{2+}:$MgAl_2O_3$ exhibiting 90%T @ 1.44um. This laser produced multiple output pulses or a "pulse train" with ~3 mj /pulse and 100ns pulsewidth. In this simple resonator configuration no intracavity focusing was required to help reach laser threshold.

A flashlamp pumped Nd^{3+}:$KGd(WO_4)_2$ (Nd:KGW) laser resonator with a 5 x 50mm rod and a 80% output coupler was operated at 1.34 um. Q-switching with a thin plate of Co^{2+}:$MgAl_2O_3$ (~0.3mm thick, 85%T @ 1.34um) produced 17 mj, 300 ns multi-mode pulses at 5 Hz pulse repetition rate As the absorption cross section of Co^{2+} in spinal is comparable to the emission cross section of Nd^{3+} in KGW intra-cavity focusing of laser beam was required. The intracavity beam waist at the spinel plate was 2.5 mm diameter.