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Further Investigation of Diode Pumped Er:glass laser
Q-switched by FTIR Method

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ABSTRACT :

TIR (Total Internal Reflection) Q-switching technology was first developed many years ago. Applications for the FTIR q-switch (Frustrated Total Internal Reflection) have been limited due to relatively slow switching times. Erbium glass lasers exhibit low gain and a long fluorescent lifetime. These conditions are favorable for the use of the FTIR Q-switch as the Erbium glass requires an extended time period to develop a Q-switched pulse.

FTIR Q-switching methods are also known as a non-polarizing Q-switch. This is because unlike E-O (Electro-Optic) Q-switching, which is based upon the rotation of polarized light by E-O effects, the FTIR uses the principal of frustrated total internal reflection. This is accomplished by changing the gap of two prisms to control the laser oscillators' intra-cavity transmission. The intra-cavity transmissions of the p-polarization, T_p and s-polarization, T_s for a FTIR Q-switch exhibit interesting behavior when examined in fine detail. Our experiments with an Erbium glass FTIR Q-switch provided various T_p and T_s values associated with different adjusted angles of incidence against the FTIR cell. These adjustments produced a 1.54 μ m laser output with different polarization states. Further optimization data for the FTIR q-switch and evaluation of the polarization characteristics of the laser's output beam are provided and compared with theoretical calculations.

An effective way to drive the FTIR Q-switch is by inducing a drive frequency that corresponds with the natural resonance of the piezo elements. This allows for efficient Q-Switching that produces less strain on the piezo elements with lower levels of required drive voltage.

Theoretical analysis indicates that T_s and T_p are controllable parameters that are influenced for the most part by the selection of the angle of incidence and the index of refraction. Experimentally, the polarization of the laser's output was carefully examined with variation of the incident angle of the FTIR (the angle between laser beam and FTIR air gap). The FTIR Q-Switch used in these experiments has a normal incident angle of 60° and a refractive index of 1.45. With the laser beam normal to the input face the laser output is partially or completely S polarized. This is consistent with the calculated results. The calculated data shows that the T_s component always exhibits higher transmission than T_p . Our calculations also indicate that at 53° incident angle, T_p equals T_s . This was confirmed by laboratory test data. The T_p and T_s behavior for various incident angles and refractive index are calculated and plotted. These curves provide us with a selection guide to the FTIR's performance based upon specific design parameters.