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LONGITUDINAL MODE SELECTION IN THE CO₂ LASER
BY INJECTION LOCKING: EXPERIMENT AND THEORY

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ABSTRACT

Several techniques have been evolved for the selection of a single longitudinal mode (SLM). Of these injection locking, where the single mode output from a low pressure or QY laser is injected into the TGA CO₂ laser cavity, has emerged as a particularly promising method, avoiding the stop banding facility of conventional operation and imposing no inherent limitation on the diameter of the TGA CO₂ gain section involved in SLM selection, so permitting large energy extraction. Operation under SLM conditions is achieved when the cw frequency is tuned close to that of a TGA cavity mode, the injected signal competing preferentially with other modes which must build up from noise.

In this work the performance of the technique is assessed for various injection geometries for both stable and unstable cavity configurations.

Towards an understanding of the physical processes involved in mode selection by injection locking we have characterized SLM operation through the functional dependence of small signal gain of the TGA CO₂ laser, and the power and frequency of the injection source on the cavity build up time to locking. These results together with the predictions of our theoretical analysis are summarized below.

CAVITY SYSTEMS

An inner stabilised frame was used to carry the optical components for the TGA and cw laser sections. For most investigations the TGA system was set up to operate in the TGA mode using a 1.4 m cavity formed by a concave diffraction grating (r/c ~ 50 m) and a plane 1" Ge output coupler, with reflectivity ~ 50%. In this configuration the laser gave output pulses of 1.1 MW peak power and 1 J energy and was fully line tunable as was the cw laser bank of which were provided with piezoelectric fine length adjustment.

A typical geometry for injection, using an external beam splitter, is shown in Fig (1). Alternative arrangements have included an intra-cavity beam splitter, oblique injection using a plane mirror, and a scattering centre (McClelland et al 1981). A typical signal under SLM operation is shown in Fig (2) along with the conventional