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FACULDADE DE CIÊNCIAS E TECNOLOGIA UNIVERSIDADE NOVA DE LISBOA

Physics department, FCT-UNL

Solar-Pumped Lasers

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Area of Scientific Research: **Solar-pumped solid-state lasers**

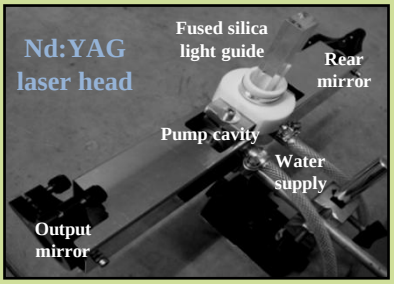
Master Degree in Biomedical Engineering

PhD student in Physics Engineering (1st year)

Objectives

The idea of directly converting broad-band solar radiation into coherent and narrow-band laser radiation has gained an ever-increasing importance in recent years. Solar-pumped lasers have a large potential for many applications, e.g. high-temperature materials processing, free space laser communications, space to earth power transmission, and so on.

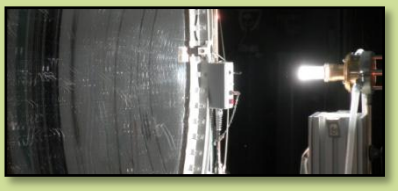
Our objective is to produce a highly efficient solar-pumped solid-state laser with high quality laser beam for the renewable magnesium-hydrogen cycle. The high temperature of 4000 K is needed for the magnesium oxide (MgO) reduction, which is very difficult to reach with conventional optics. Solar-powered lasers with excellent beam quality became hence essential for this application.



Methodology

A heliostat with a plane mirror and a parabolic mirror are generally combined to pump a solar laser. In indirect tracking mode, a large plane mirror is mounted on a heliostat which redirects the incoming solar radiation to a stationary parabolic mirror. The laser head can be conveniently mounted at the focal area of the parabolic mirror. Fresnel lenses can also be used as solar collection and concentration systems. A fused silica light guide (or light guide assembly) is used to both transmit and homogenize the highly concentrated solar radiation from the focal zone to the entrance aperture of a water-cooled pump cavity, within which a Nd:YAG laser rod is efficiently pumped. The optical resonator is comprised of two opposing mirrors at right angles to the optical axis of the rod. The rear mirror is high reflection coated (HR,99.98%) for the laser emission wavelength, while the output mirror is partial reflection coated (PR).

Nd:YAG solar laser experiments

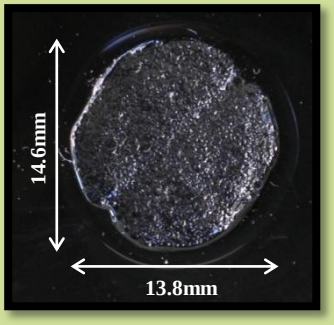


Expected Results

Experimental results:

Record collection efficiency of 9.6 W/m^2 for solar laser pumped through heliostat-parabolic mirror system has been attained. Record-high brightness figure of merit of 0.29 W has been registered. The introduction of the rectangular cross-section light guide has ensured a more stable laser emission than previous pumping schemes. Significant improvement in slope efficiency and substantial reduction in threshold pump power are also promising features of our solar laser scheme.

The solar-pumped Nd:YAG laser system could provide an effective solution for attaining high quality solar laser beam, essential for both tight focusing in high temperature material research and space applications.



Laser beam profile

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