Multi-kW Class CW Laser-induced Damage Assessment of Metals and Carbon Fiber in a Mobile Research Laboratory

Ali Al Blooshi, Amit Dubey, Layla Al Shehhi, Guillaume Matras, Antaryami Mohanta,
Shaikha Al Marzooqi, Aaesha Alteneiji, Bader Al Ali, Chaouki Kasmi
Directed Energy Research Center
Technology Innovation Institute
Abu Dhabi, United Arab Emirates
Ali.AlBlooshi@tii.ae

***Abstract*—**
A multi-kW class laser mobile research laboratory (LMRL) capable of facilitating indoor and outdoor research activities is used to assess high-power continuous wave (CW) laser-induced damage to metals and carbon fiber. A short-range telescope system coupled with the laser was used to focus the beam onto the samples and the experiment was conducted in an indoor environment. The drilling process was monitored by high-speed imaging, which provides information about the interaction time required to damage the target. The laser power, beam diameter, laser exposure time, etc. were varied and the target damage assessment was carried out.

Keywords: Multi-kW class CW laser, Fiber laser, Metals, Carbon fiber, Laser exposure time.

I. INTRODUCTION

Direct energy system for counter-drone technologies have been paid increasing attention to damage/ neutralize the unmanned aerial vehicles (UAVs) involved in potentially harmful activities. Several industrial-grade laser systems have been developed for materials processing, which can be used as directed energy systems for countermeasure in a mobile platform [1]. The availability of high-power commercial fiber lasers opens an opportunity to develop a multi-kW class laser-based demonstrator in a mobile platform due to flexible beam delivery, low maintenance cost, high efficiency, and compact size [2]. A mobile platform can also facilitate research activities both in an indoor and outdoor environment.

In this work, we have used a multi-kW class laser mobile research laboratory (LMRL) to perform high-power laser damage assessments experiment in the indoor environment. Aluminum, steel, and carbon fibers are exposed to the high-power laser at a fixed distance, and the drilling process is monitored by a high-speed camera. The high-speed images are analyzed, and the damage/drilling time is obtained at different laser powers, beam diameters, and laser exposure times.

II. MULTI-KW CLASS LASER MOBILE RESEARCH LABORATORY (LMRL)

A. Components of LMRL

The key components of the LMRL shown in Fig.1 are a 6 kW CW fiber laser source (λ = 1080 nm), telescopes with a range covering from 3 to 2000 m, laser range finder, short and long-range video systems, and high-speed cameras equipped with a 20-foot standard container with the desert compatible environment.

Fig. 1. Photo of LMRL (telescope and container).

B. Experiment Set-up

The effect of laser irradiation on the static targets (aluminum, ABS plastic, and carbon fibers) kept at fixed distance was investigated. The laser powers used were varied from 1 to 6 kW, beam diameters were varied from 10 to 50 mm, and material thickness was 2 mm for aluminum, 1.5 mm for ABS and 3 mm for carbon fiber.

From the experiment results, it is feasible to study the vulnerability effects on different materials. The dependence of beam diameter and power radiation on the time needed to penetrate different materials can be assessed.

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