SBIR Directs Energy Towards Laser-Based Target ID

Small Business Innovation Research funded by AFRL and completed by Nanohmics, Inc., generated an Optical Target Identification System (OTIS) for directed energy weapons research. Pictured is the OTIS setup used for field-based laser experimentation. (Photo courtesy of Ron Sullivan, Nanohmics)

The 532 nm scattered light from a diffuse target illuminates Nanohmics, Inc., researchers during the team's field-based laser experimentation. (Photo courtesy of Ron Sullivan, Nanohmics)

AFRL-sponsored Small Business Innovation Research (SBIR) dedicated to improving target identification technology precipitated development of an Optical Target Identification System of benefit to directed energy weapons advancement, such as that facilitated by the Airborne Laser (ABL) and Advanced Tactical Laser (ATL) programs. The resultant instrumentation—a world-class laboratory scatterometer that serves government, commercial, and academic purposes—provides a means both for measuring and analyzing Bidirectional Polarization Reflectance Distribution Functions (BPRDF) and for performing surface characterization of optical and semiconductor components. The SBIR-enabled technology—which can measure four-dimensional BPRDF of both opaque and transparent samples, even at measurement angles very close to the source direction (<0.05°)—could complement radar and passive infrared (IR)/visible sensor capabilities on a host of Air Force weapons platforms (ABL, ATL, and beyond). It could likewise enhance preattack target determination, aim-point maintenance and fire control, and postattack target assessment.

Based on their inherent capacity to positively identify a target—and thus maximize weapon efficiency while minimizing collateral damage—directed energy laser weapons are desirable for high-precision strike missions from mobile platforms. However, robust laser-based target discrimination demands comprehensive scattering models heretofore unavailable. SBIR contractor Nanohmics, Inc., addressed this need by (1) creating and validating scattering models that leverage basic properties of laser light at nondestructive power levels to detect differences (or changes) in target orientation, composition, and microstructure; (2) deriving from these models the measurements and algorithms needed for identifying and distinguishing targets of interest; and (3) demonstrating optimal target discrimination schemes in laboratory and field settings.

Nanohmics tested the capacity of its hardware and algorithms to identify different target materials under coherent near-IR illumination and over ATL-relevant atmospheric propagation paths. The company also performed an extensive series of BPRDF measurements on various materials both in the laboratory and in two sets of field experiments. The lab-based results reflect state-of-the-art measurements taken with a large-dynamic-range, high-precision instrument under ideal conditions, whereas the field outcomes represent the same series of measurements, but obtained under atmospheric propagation conditions consistent with an air-to-ground ATL engagement scenario. More specifically, the field data embodies BPRDF measurements collected under the imperfect conditions of turbulence-induced beam jitter and scintillation of scattered radiation.

In an attempt to verify the efficacy of identifying target materials using BPRDF measurements alone, researchers subjected the data obtained from both the lab and the field to tests involving two different types of material classifiers. Classification results indicate that in discriminating among the diverse material types, textures, and compositions measured throughout the experimental program, a Bayesian classifier provided correct material determinations approximately 60% of the time.