Air Force SBIR/STTR Innovation

Air Force SBIR/STTR Innovation Story

SBIR Topic Number:
AF05-002

SBIR Title:
Target Discrimination Based on Rigorous Models of Laser Scattering from Complex Media

Contract Number:
FA9451-06-C-0026

SBIR Company Name:
Nanohmics, Inc., Austin, TX

Technical Project Office:
AFRL Directed Energy Directorate, Kirtland AFB, NM

RD09-0964

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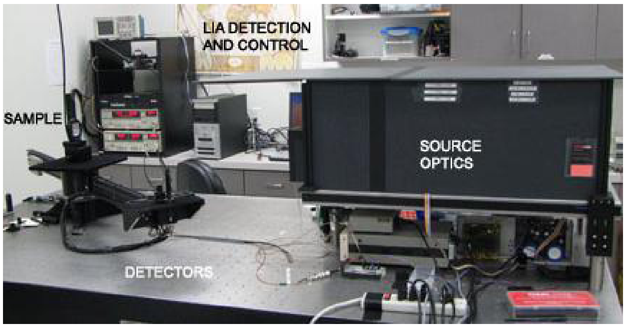
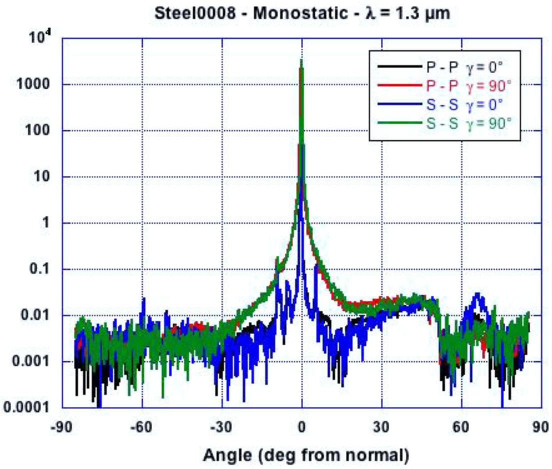
This Air Force SBIR/STTR Innovation Story is an example of Air Force supported SBIR/STTR technology that met topic requirements and has outstanding potential for Air Force and DoD.





Left: Nanohmics laboratory scatterometer instrument for measurement of Bidirectional Polarization Reflectance Distribution Function (BPRDF) for opaque (reflected) or transparent materials (reflected and transmitted). Detector is capable of measuring within 0.05º of source and has 10^6 dynamic range. Right: Measured monostatic BPRDF measurements of steel plate.

Target Identification Via Laser-Material Interaction

- There is a need to develop and test scattering models that enable optimal utilization of basic properties of laser light at non-destructive power levels for the detection of differences or changes in target orientation, composition, and microstructure

- Nanohmics developed and tested hardware and algorithms for determination and discrimination of different target materials under coherent illumination in the near IR, over Advanced Tactical Laser (ATL)-relevant atmospheric propagation paths, and designed a target identification system that can be utilized in experiments

- The data obtained during this program led to the design of an Optical Target Identification System (OTIS) for both the Airborne Laser and Advanced Tactical Laser programs

- This instrument exceeds the performance of the Air Force ResearchLaboratory scatter instrument at Wright Patterson Air Force Base, and is presently being used to provide scatter measurement and surface analysis services to industry and academia

Air Force Requirement

Directed-energy laser weapons, such as the Advanced Tactical Laser (ATL), are being developed for high-precision strike missions from mobile platforms. In this context the ability to positively identify a target will maximize the efficiency and minimize the collateral damage associated with laser weaponry. Directed-energy systems employ coherent, typically polarized illuminators and collocated detectors in the backscattering or monostatic geometry, and the basic physics of laser-target interactions in directed-energy systems is therefore significantly different from that encountered in passive systems, which utilize solar or thermal emission sources. As a result, effects that are not observed under passive illumination, including laser speckle and coherent backscattering, arise in directed-energy systems, the description of which generally demands more rigorous and diverse models than are necessary in the passive case. Robust laser-based target discrimination will require more comprehensive scattering models than are currently available. Therefore, there is a need to develop and test scattering models that enable optimal utilization of basic properties of laser light at non-destructive power levels for the detection of differences or changes in target orientation, composition, and microstructure; derive from these models optimal measurements and algorithms for the identification and discrimination of targets of interest; and demonstrate optimal discrimination schemes in laboratory and field settings.

SBIR Technology

Nanohmics developed and tested hardware and algorithms for determination and discrimination of different target materials under coherent illumination in the near IR, over ATL-relevant atmospheric propagation paths. Additionally, Nanohmics designed a target identification system that can be utilized in experiments.

An extensive series of polarization-sensitive Bidirectional Polarization Reflectance Distribution Function (BPRDF) measurements were made on a wide variety of materials both in the laboratory and in two sets of field experiments. The laboratory results represent state-of-the-art measurements with a large dynamic range, high-precision instrument under ideal conditions. Field experiments were designed to perform the same series of measurements, but under atmospheric propagation conditions consistent with an air-to-ground engagement scenario of the ATL. As such, the field experiments embody BPRDF measurements made under the imperfect conditions of turbulence-induced beam jitter and scintillation of returned scattered radiation. Measurement data from both laboratory and field experiments were subject to tests of two different types of material classifiers in an attempt to determine the efficacy of material identification from BPRDF measurements alone. Classification results indicate that, among the wide range of material types, textures, and compositions measured during the experimental program, a Bayesian classifier could determine the material correctly approximately 60% of the time.

Potential Air Force Application

Target identification technology could complement or supplement radar and passive IR/visible sensor data on a host of different Air Force weapons platforms (not just ATL), and provide enhanced pre-attack determination of target, enhanced aim-point maintenance and fire control, and enhanced post-attack assessment. A target identification system could be wavelength-agile, share existing optical apertures, and would provide orthogonal information about target dynamics, shape, and composition. The data obtained during this program led to the design of an Optical Target Identification System (OTIS) for both the Airborne Laser and Advanced Tactical Laser programs. The development of a world-class scatter measurement laboratory provides full service BPRDF measurement and analysis to both government and commercial customers as well as surface characterization services for optical and semiconductor industry components.

Company Impact

Nanohmics benefited from an early commercialization opportunity in which it was able to sell measurement and analysis services to both government and industrial customers. An excellent side effect of this program was the development of a world-class laboratory scatterometer instrument, capable of measuring full 4D Bidirectional, Polarization Reflectance Distribution Functions of both opaque and transparent samples, even at measurement angles very close to the source direction (<0.05°). This instrument exceeds the performance of the Air Force Research Laboratory scatter instrument at Wright Patterson Air Force Base, and is presently being used to provide scatter measurement and surface analysis services to industry and academia.

Located in Austin, Texas, Nanohmics was founded in 2002 by a group of entrepreneurial scientists and engineers to turn cutting edge research into commercial technology.