Micro BRDF Measurements with Infrared Quantum Cascade Laser Sources

Patrick McArdle[1, S, C], Chris Yung[1], Nathan Tomlin[1], John Lehman[1] and Michelle Stephens[1]

[1]*NIST, Boulder, CO, U.S.A.*
pjm5@nist.gov

Characterizing the absorption efficiency of microscopic absorbers at infrared wavelengths is becoming a necessity as more applications emerge such as in detector technologies[1], frequency selective filters[2] or in photonic assemblies[3]. Directional-hemispherical reflectance (DHR) measurements on microscopic areas at infrared wavelengths are the most direct measurement for characterizing this class of materials. However, performing a DHR measurement at these lengths scales is not practical due to the low signal to noise nature of the measurement. To address this problem, we will present work on the development of micro-bidirectional reflectance distribution function (BRDF) measurements using state of the art infrared quantum cascade lasers. Infrared QCLs at wavelengths ($\lambda > 10$ μm) are an emerging technology which is enabling optical measurements at near the diffraction limit resolutions in the infrared. From the BRDF we are able to extract a DHR at microscopic length scales and thus are able to characterize an absorber's infrared reflectance and absorption properties. To demonstrate the setup, micro-BRDF results on small-area vertically aligned carbon nanotube detectors for Earth outgoing radiation measurements will be presented and discussed.

References

1. J. Lehman, C. Yung, N. Tomlin, D. Conklin, and M. Stephens, "Carbon nanotube-based black coatings," Applied Physics Reviews **5**(1), 011103 (2018).
2. T. Zhang, J. Yu, Q. Wulan, Z. Li, and Z. Liu, "Diffuse reflection in periodic arrayed disk metasurfaces," Opt. Express **29**(18), 28277 (2021).
3. Y. Gong, X. Liu, H. Lu, L. Wang, and G. Wang, "Perfect absorber supported by optical Tamm states in plasmonic waveguide," Opt. Express **19**(19), 18393 (2011).