12

An Inverse Numerical Simulation for Simultaneous Measurement of Non Spherical Particle Size and Optical Constant by Forward Elastic Light Scattering and Transmittance*

© Md Arafat Islam[1,2], Hong Qi[1,2,¶], Ya-Tao Ren[1,2], Jun-You Zhang[1,2], and Li-Ming Ruana[2]

[1] School of Energy Science and Engineering, Harbin Institute of Technology,
150001 Harbin, China
[2] Key Laboratory of Aerospace Thermophysics, Ministry of Industry and Information Technology,
150001 Harbin, China

e-mail:qihong@hit.edu.cn

Received May 30, 2019
Revised May 30, 2019
Accepted October 28, 2019

This numerical study investigates the feasibility of simultaneous retrieval of particle size distribution (PSD) and optical constants of spheroids by optical spectroscopy. In this simulation the particles are considered as spheroid. The aspect ratio of an oblate and prolate spheroid is set as 0.8 and 1.2, respectively. At this constant aspect ratio, the particle's orientation has been changed by altering its major semi-axis. Two continuous wavelength lasers are employed to irradiate the particle samples. Multi-angle and multi-wavelengths elastic forward scattering intensity and the spectral collimated transmittance are employed to measure signals. For forward scattering, the spheroid is effectively replaced by a sphere of an approximated radius and the modified Mie theory is employed to calculate the scattering intensity. For the collimated transmittance, the extinction efficiency of non-spherical particle is measured based on the extended anomalous diffraction approximation. The Log-Normal distribution is used to get the volume frequency distribution of the particles and the inverse process is done by using the improved quantum particle swarm optimization. Two different sets of optical constant (e.g. complex refractive index), semi-major axis of non-spherical particle and discrete rate are retrieved by the inverse simulation. The results show that the proposed spectroscopic technique can retrieve PSD and optical constants of non-spherical particles simultaneously within the tolerable error limit less than 10%.

Keywords: Non-spherical particles, improved quantum particle swarm optimization (IQPSO), the forward elastic scattering intensity, the collimated transmittance, the extended anomalous diffraction algorithm (ADA).

* Полный текст статьи опубликован в „Optics and Spectroscopy“ V. 127 N 6 2019.