

MODELING BIDIRECTIONAL REFLECTANCE OF MATERIALS USED IN
REMOTE SENSING

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ABSTRACT

The experimental bidirectional reflectance function taken in the principal plane is fit using a five parameter model, The experimental data are from reference materials used in the visible and infrared.

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In atmospheric laser remote sensing and satellite radiometers there is a need to calibrate the signals in order to determine the absolute backscatter values and to reference the radiance fields viewed by the radiometers. Each of these techniques requires knowledge about the bidirectional reflectance distribution function of the reflecting materials employed as standards. The remote sensing of atmosphere from infrared lidar stations requires that the return backscatter signal be calibrated. These systems are usually bistatic; thus the reflected radiance in calibration will include the diffuse and the retroreflectance characteristics of the calibration standard. In the case of orbiting sensors, the bidirectional reflectance properties of the calibration standards must be developed for a range of incident and reflected angles corresponding to the scenario of the sun's position relative to the calibrator during the trajectory of the sensor. In order to meet the unique needs for these sensing techniques it is desirable that a physically derived model be developed with parameters which can be found that characterize the reflectance properties of the material,

Models have been developed which meet this need and are chosen with reference to the general properties of the reflecting surface and the material ^(1,2).

The model selected for this study is described by: B. Hapke and E. Wells '3); and is given by:

$$r = (w/4)(\mu_0/(\mu_0 + \mu)) \{ [1 + B(g, h, B_0)] p(g, b) + H(\mu_0, w) H(\mu, w) - 1 \}$$

where:

r is reflectance

p(g, b) is the single particle phase function,

g is the phase angle, containing one parameter b,

B(g, h, B₀) is the backscatter function including retroreflectance effect, containing two parameters, h and B₀, which are measures of the width and height of the retroreflectance peak,

w is the particle single scattering albedo,

H(μ₀, w), H(μ, w) are functions which describe the isotropic scatterers.

μ₀, μ are cos (incident angle), cos (reflected angle).

The object of our study is to apply this theoretical model to the large body of

PHOTOMETRIC REFLECTANCE FUNCTION

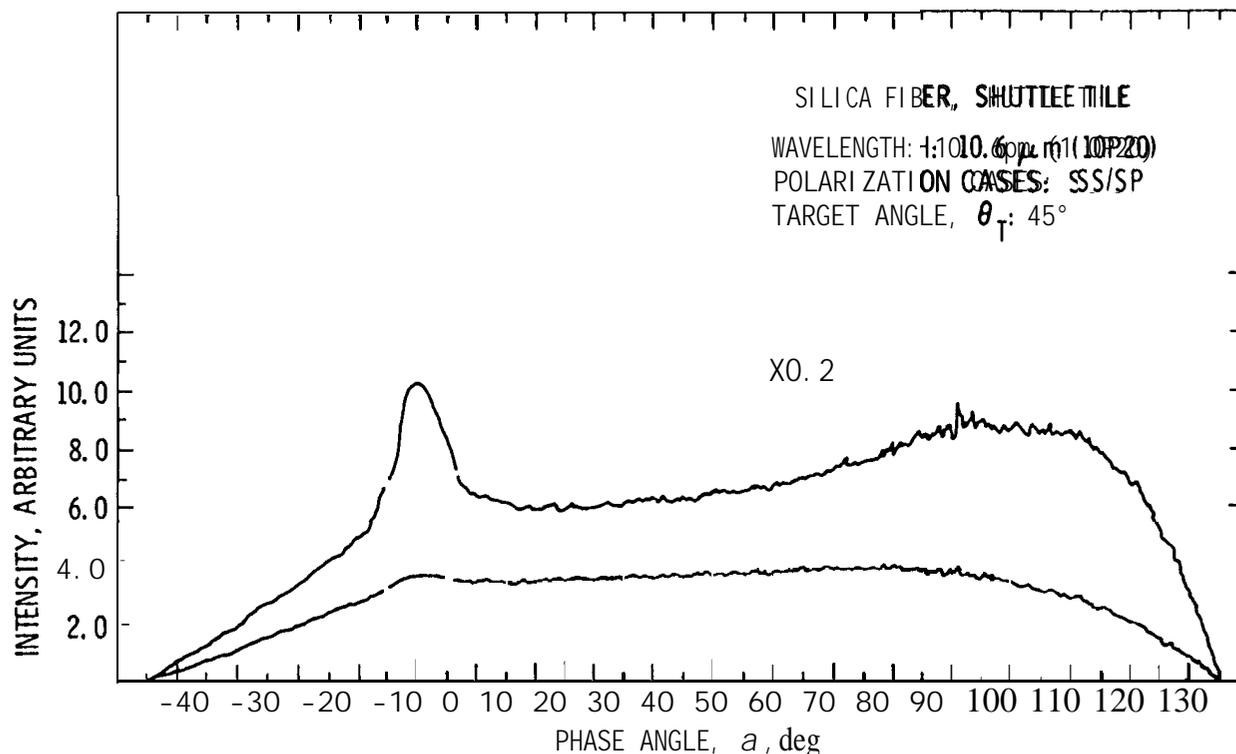


Figure 1

reflectance data as shown in figure 1 for both visible and infrared wavelengths acquired in the calibration facility to obtain the parameters required to describe the materials ^(4,5).

This objective will be realized by fitting the data using the minimum χ^2 procedure ⁽⁶⁾. The general search procedure is to calculate the χ^2 at successive points by an iterative process in such a way as to approach the χ^2 minimum with a acceptable amount of computing. Since an analytical model describes the phenomenon, the determination of the succeeding points are estimated by solving the sets of linear equations in parameter space which are derived from the Taylor's expansion of χ^2 (which contains the model explicitly) about the initial point in parameter space. The effect of detector angular resolution will be included as required. As this study progresses the model changes required to describe polarization variations will be developed and included. This work and the results of our continuing effort directed toward the characterization of target materials will be presented and discussed.

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