OPTICAL CONSTANTS OF KEROGEN FROM 0.15 TO 40 μm: COMPARISON WITH METEORITIC ORGANICS

B.N. Khare, W.R. Thompson and C. Sagan
Cornell University
Ithaca, NY 14853 USA

E.T. Arakawa and C. Meisse
Oak Ridge National Lab.
Oak Ridge, TN 37831

I. Gilmour
The Open University
Milton Keynes MK7 6AA
U.K.

ABSTRACT. A vacuum evaporation technique has been used to produce thin, optical quality films of samples of Type II kerogen and of insoluble organic residue from the Murchison meteorite. Using these films, optical constants have been measured from 0.15 to 40 μm for kerogen, and from 2.5 to 40 μm for the Murchison residue. The infrared absorption properties of these materials show many similarities, although Murchison residue is more opaque throughout the infrared than is kerogen, and shows no distinct aliphatic absorptions.

1. INTRODUCTION

Interplanetary dust is thought to derive from cometary, asteroidal and meteoritic sources along with a possible contribution from planets and presolar dust. Both meteoritic organic residues and kerogens (dark, complex organic materials produced on the Earth primarily by geological processing of biologically derived material) have been used as laboratory models of dark extraterrestrial organic materials. Kerogen-like solids have been proposed as constituents of the very dark reddish surfaces of some asteroids (Gradie and Veverka, 1980), and kerogens and meteoritic organics are also spectrally similar to the Iapetus dark material (Bell et al., 1985). The optical constants of these materials are useful for modeling the scattering properties of interplanetary and cometary dust, and also of asteroid and satellite surfaces.

2. EXPERIMENTAL METHODS

We have measured the optical constants of both Type II kerogen and of a macro-molecular organic residue from the Murchison carbonaceous chondrite via transmission and reflection measurements on thin films. These films, of thickness 0.2-1.3 μm, are produced by vacuum deposition of powdered samples heated to 550-750°C onto sapphire, CaF_2, and CsI substrates. IR spectra of the thin films show that the spectral features of the powder are retained and thus no substantial change in the optical constants occurs upon vacuum deposition.

A.C. Levasseur-Regourd and H. Hasegawa (eds.), Origin and Evolution of Interplanetary Dust, 99–101.

3. RESULTS

The real part of the refractive index, n, of Type II kerogen is determined by variable incidence-angle reflectance to be 1.60 ± 0.05 from 0.4 to 2.0 μm wavelength. Work extending the measurement of n to longer wavelengths is in progress. The imaginary part of the refractive index, k, of kerogen shows substantial structure from 0.15 to 40 μm (Fig. 1). The values are accurate to $\pm$ 20% in the UV and IR regions and to $\pm$ 30% in the visible. Our measurements of k for Murchison organic residue in the IR are shown and compared with the kerogen results in Figure 2. The Murchison sample, like the kerogen, shows considerable spectral structure, but as expected, does not show any feature associated with aliphatic functional groups. Comparison of the kerogen and Murchison data reveals that between 0.15 and 40 μm, Murchison has a similar structure but no bands as sharp as in kerogen, and that the k values for Murchison are consistently larger than those of kerogen. Further measurements of n and k for Murchison organic residues are in progress.

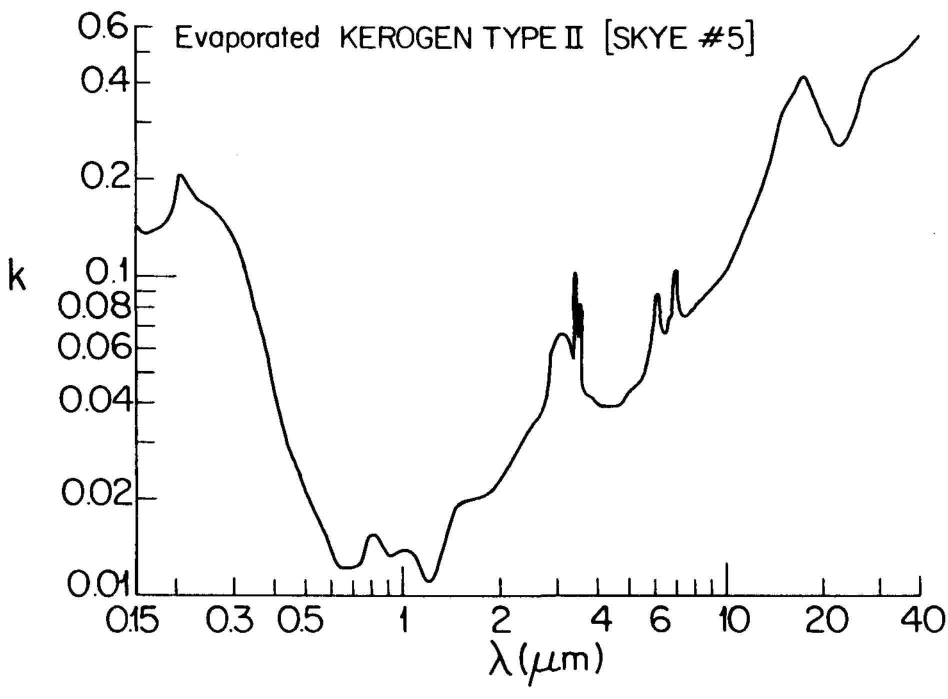

Figure 1. Imaginary part of the refractive index, k, for vacuum-evaporated Type II kerogen. Spectral absorption features (corresponding to maxima in k) include the aliphatic CH_x bands near 3.4 μm.

https://doi.org/10.1017/S0252921100066562 Published online by Cambridge University Press

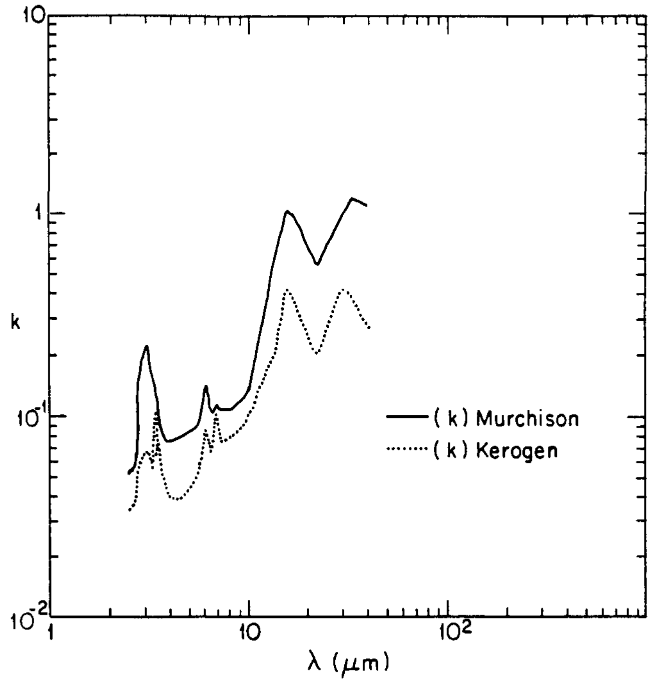

Figure 2. The infrared spectral dependence of k for Type II kerogen is compared with that of Murchison organic residue. The spectra show some similarities, but the Murchison residue is more opaque overall, while the kerogen shows aliphatic absorptions at 3.4 and 7 μm which are weak or absent in the Murchison spectrum.

REFERENCES

Bell, J. F., Cruikshank, D. P., and Gaffey, M. J. (1985) 'The composition and origin of the Iapetus dark material', Icarus 61, 192.

Gradie, J. and Veverka, J. (1980) 'The Composition of the Trojan asteroids', Nature 283, 840.