INFRARED ABSORBANCE OF MINERAL POWDERS: CORRECTIONS BASED ON PARTICLE SIZE DISTRIBUTION

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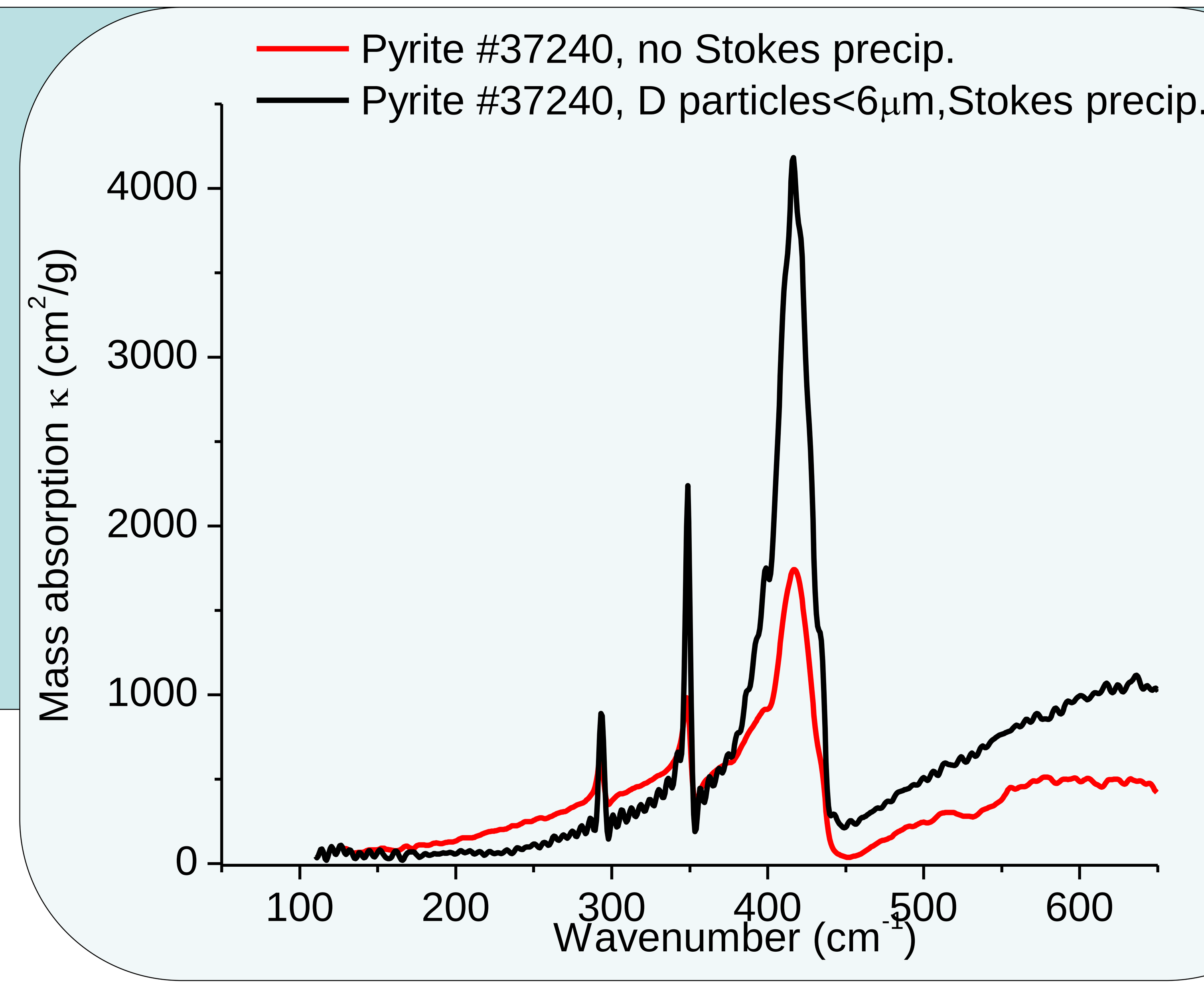
ABSTRACT

Far-infrared absorption spectra of mineral powders bear characteristic features that can be used to interpret emission spectra of astrophysical dust populations. We are collecting such mineral spectra in support of the Herschel Space Observatory data return. To avoid saturation of the absorbance, the effective thickness of the mineral samples must be less than a few microns, and this is best achieved by dispersing micron-size mineral particles in a polyethylene host. If particle sizes exceed the effective thickness, then the absorption coefficients derived from the data will be quantitatively inaccurate. This paper presents a method of correcting the absorption spectra for actual particle size distributions determined from scanning electron microscopy.

Experiment

Comparison of mineral absorption between a Stokes precipitated and an as-ground Pyrite. As the particle size distribution becomes finer, an *increased* value of the mass absorption coefficient is attained, as expected.



BACKGROUND

Mass absorption Coefficient (κ) and absorption coefficient (α_0) are both determined from the transmittance spectrum (T) of a given sample (EQ1 & EQ2); where cross sectional area (S), density (p) & mass of sample (m) are predetermined. If the average particle size (APS), determined from a Scanning Electron Microscope in this experiment, is smaller than the effective thickness (d_0-EQ3) then equation 1or 2 may be used accurately to determine the coefficients. However in this experiment the APS has been larger than d_0. In order better calculate these coefficients a new formula has been devised (EQ4); where d is the APS. This equation is derived from the thought experiment to the right.

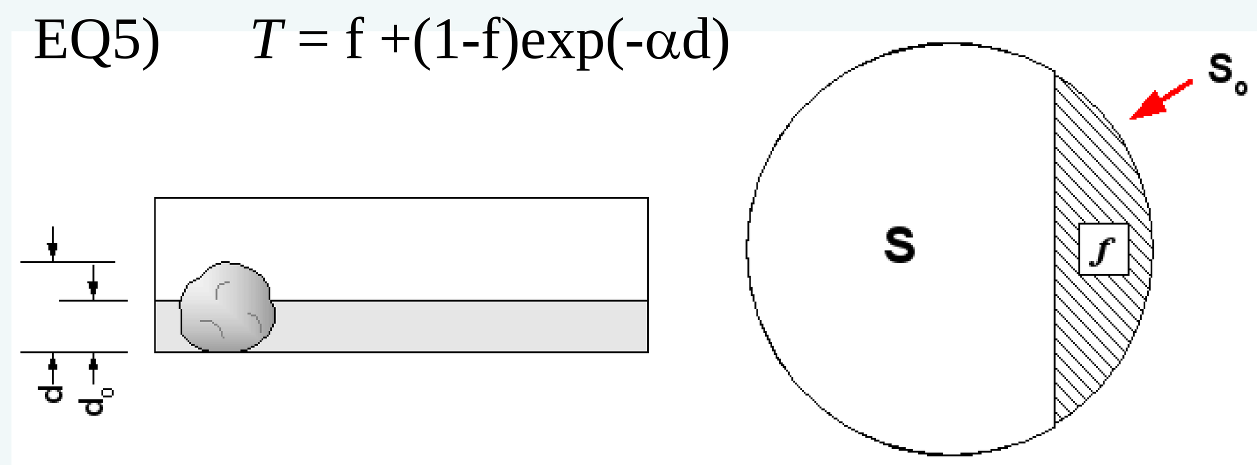
EQ1) $\alpha_0 = -(1/d0)*\ln T$

EQ2) $\kappa = -(S/m)*\ln T$

EQ3) $d_0 = m/(S*p)$

EQ4) $\alpha = -(1/d)\ln[(d/d_0)(T-1) + 1]$

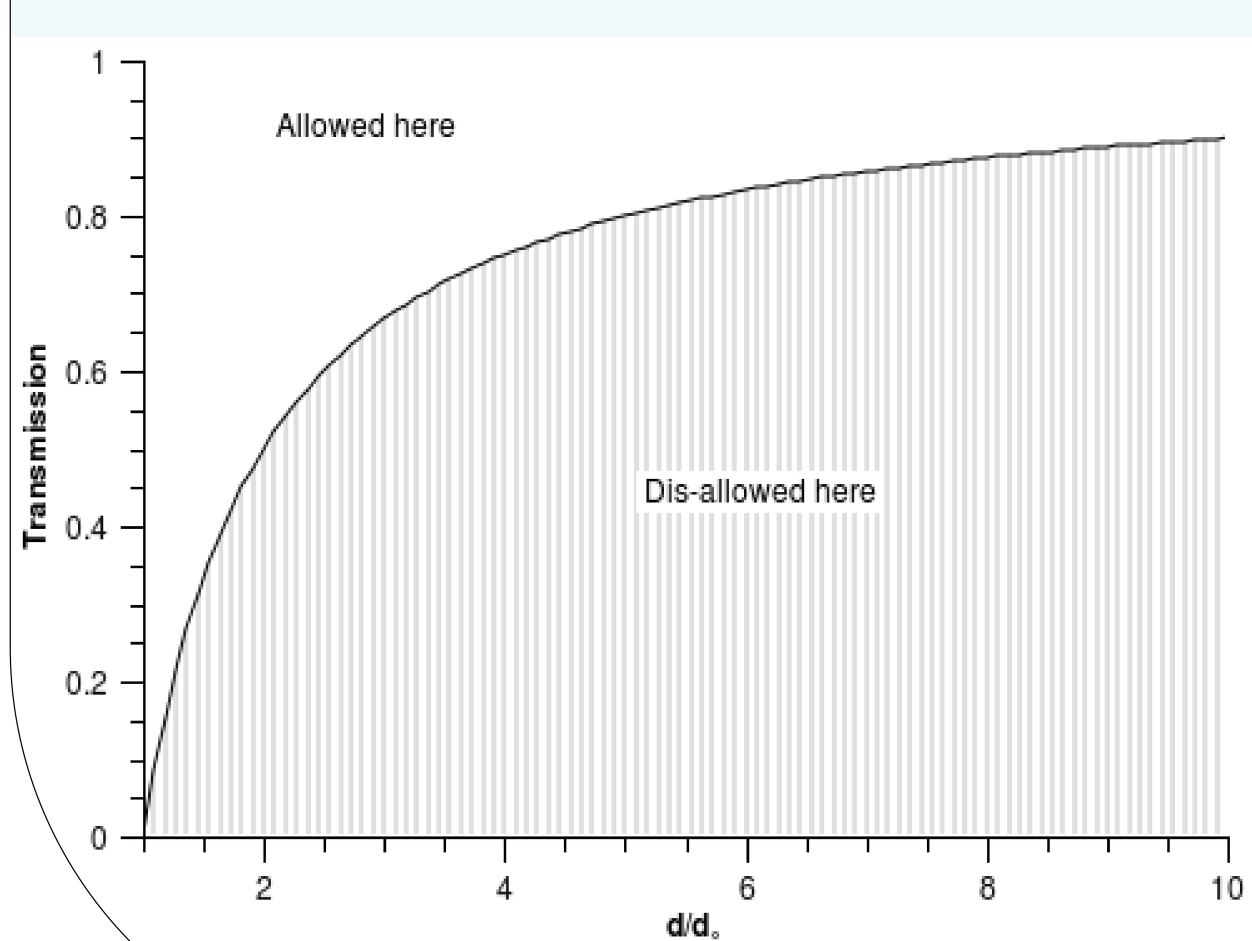
EQ5) $T = f + (1-f)\exp(-\alpha d)$

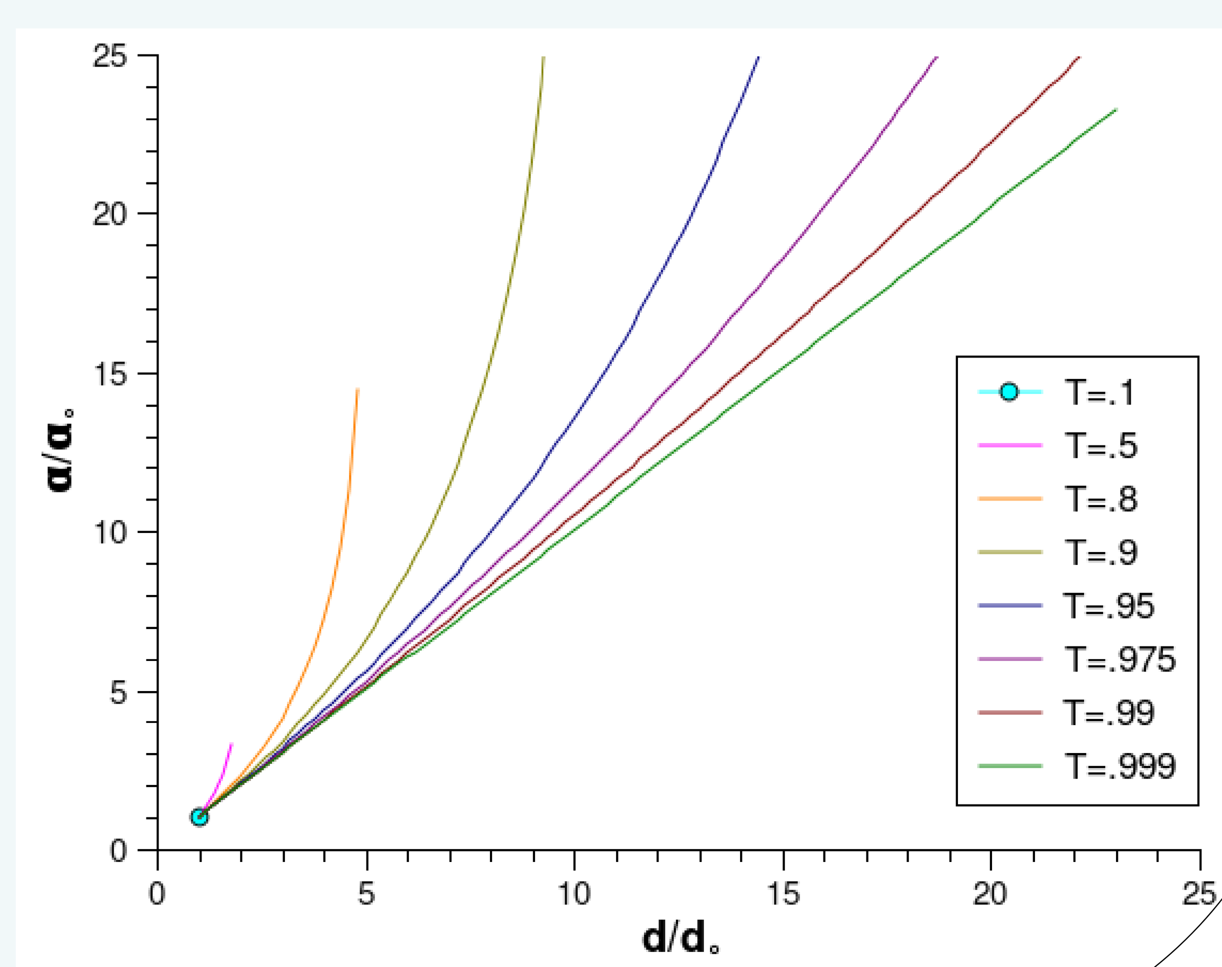


Top: Suppose a fraction (f) of a pellet has no mineral & has an area S < S_0 with d>d_0. Then f = 1-S/S_0 so that EQ5 is valid. Solving for α and noting $S_0 d_0 = Sd$, EQ4 is obtained.

Bottom Left: Transmittance values for which correction formula may be applied as function of d/d_0.

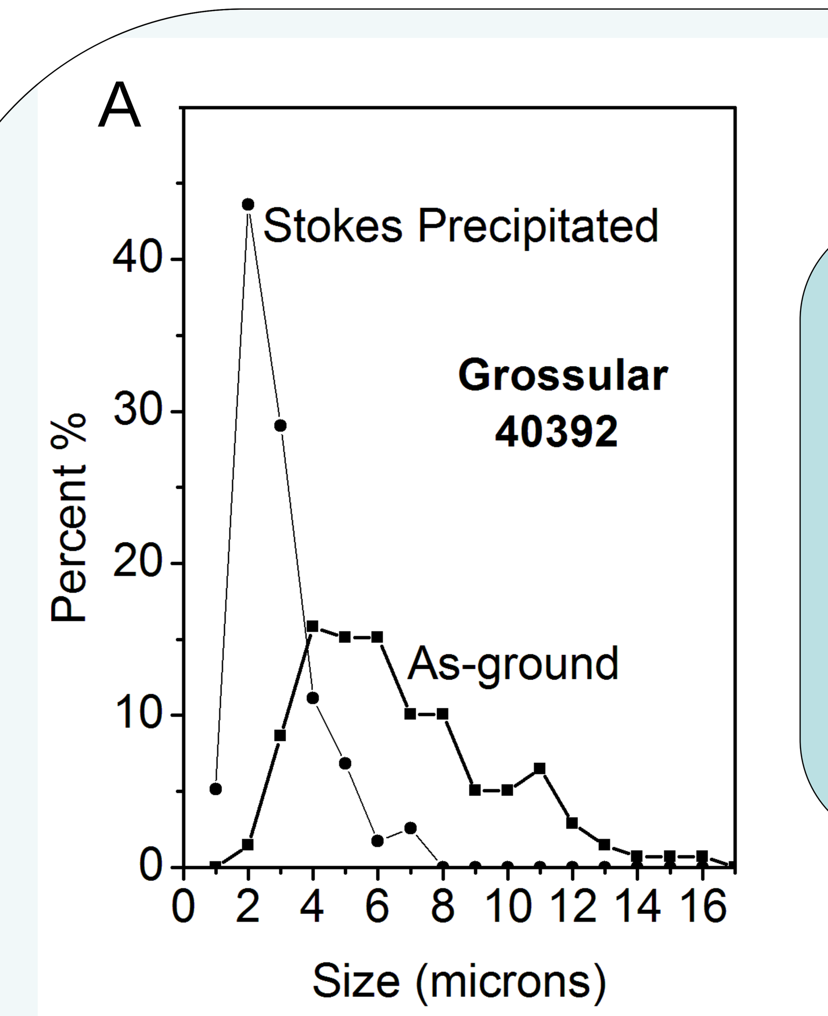
Bottom Right: Correction factor as function of d/d_0.

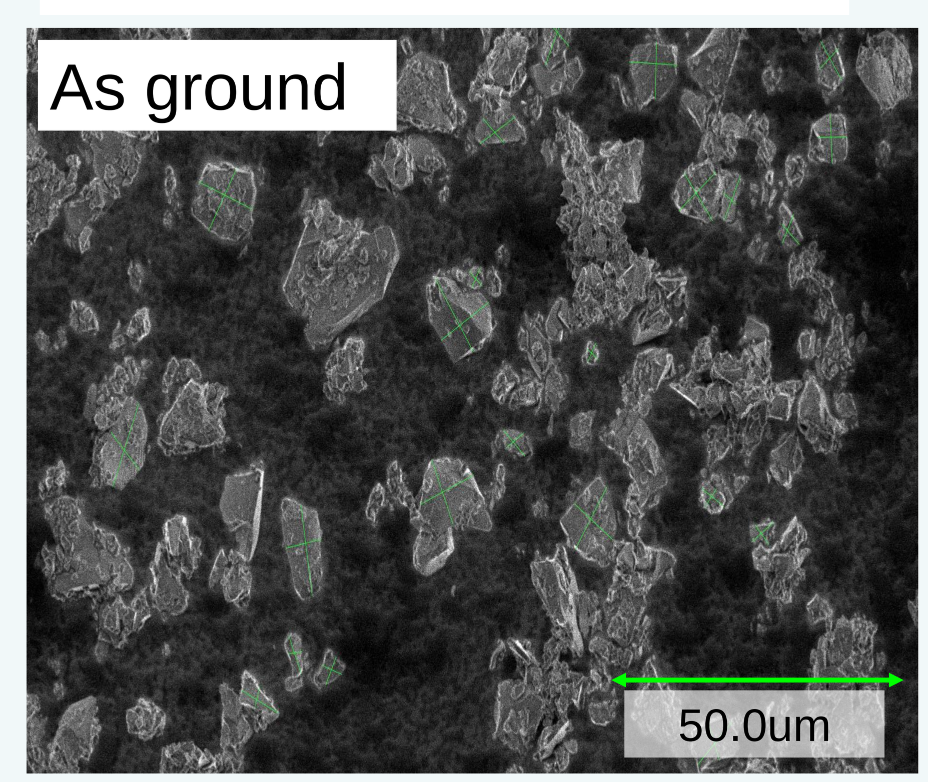


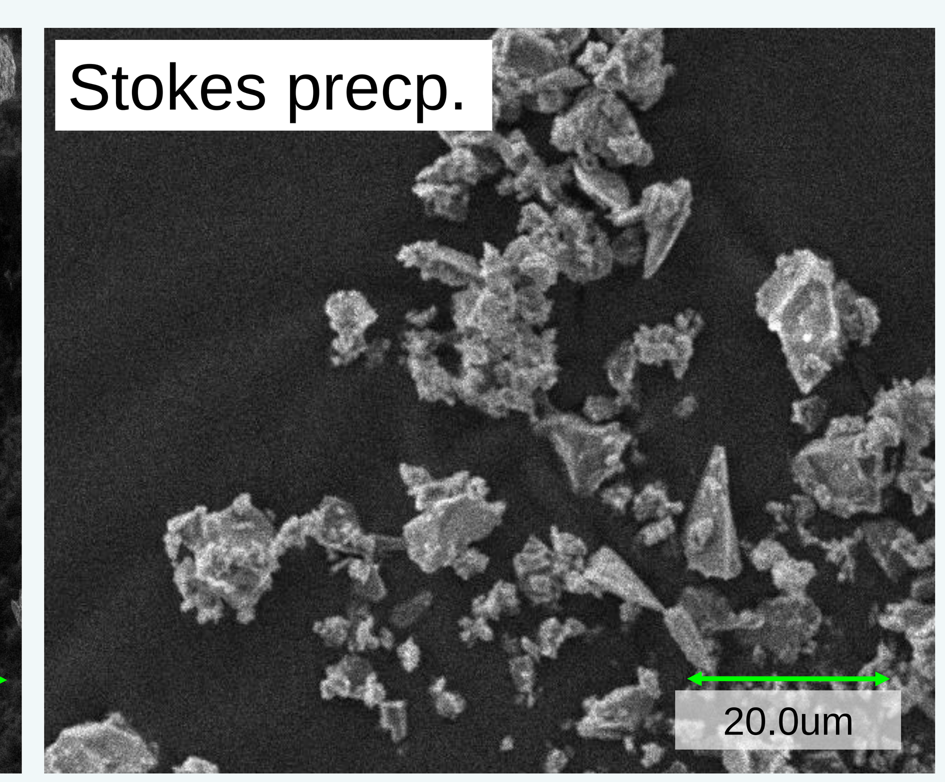


SIZE DISTRIBUTIONS

Percent size distribution of Grossular particles measured in both As-ground SEM image and Stokes Precipitated SEM image.







Acknowledgments

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