

All data taken at Pacific Northwest National Laboratory (PNNL)

**Operators:** Jerome C. Birnbaum, Tyler O. Danby, Timothy J. Johnson, Molly Rose K. Kelly-Gorham, Rodica Lindenmaier, Tanya L. Myers

**SAMPLE CONDITIONS & PHYSICAL PROPERTIES**

Chemical name	Powdered Sugar	
Chemical formula	C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	
Synonyms	Confectioner's sugar; 10-X sugar; Frosting sugar; Icing sugar	
CAS number	n/a	
Location of field sample	n/a	
History of sample	n/a	
Molecular Weight	342.30 g/mole (sucrose)	
Melting Point	170-186 °C	
Boiling Point	Decomposes	
Density (25° C)	1.58 g/cm <sup>3</sup>	
Hardness, Mohs scale	n/a	
Crystallography:		
Cell dimension	a = Å b = Å c = Å	
Crystal system		
H-M symbol (point gr)		
Space group		
H-M symbol (space gr)		
Crystal habit		
Color	White	
Diaphaneity	Opaque	
Particle size	17 ± 6 µm	
Particle size assessment	Optical microscopy	
Supplier	Kroger	
Stated purity	>95% (3-5% cornstarch)	
Date packed	17 February 2016	Weight: 1.369 grams
Synthesis method	n/a	
Synthesis reference	n/a	
Texture	Fluffy hygroscopic powder	
Physical state	Solid	
Surface roughness	n/a	
Elemental composition	n/a	
Isotopic composition	n/a	
Moisture content	n/a	
Temperature of sample	25 ± 2 °C	
Substrate	n/a	

## INSTRUMENT PARAMETERS

### Tensor 37 FT-IR manufactured by Bruker Optics

External diffuse reflectance accessory	A 562-G integrating sphere
Sphere diameter	75 mm
Angle to normal incidence	14.8°
Sphere opening diameter	19 mm (entrance port)
Spectral range	7,500 to 600 cm <sup>-1</sup> saved; 7500 to 600 cm <sup>-1</sup> reported
Beamsplitter	Ge on KBr
Detector (dia. Det. Port in sphere)	2×2 mm, 60° field of view MCT (550; 0.9); 1 cm
Apodization function	Blackman-Harris 3-term
Aperture	6 mm
Coadded scans	2048
Scanner speed	40 kHz
Switch gain on	512 points
Low pass filter	Open
Scan technique	double-sided, forward-backward
Non-linear correction	On
High and low folding limit	15800.54-0.00 cm <sup>-1</sup>
Phase resolution	32.00
Phase correction mode	Mertz
Zerofilling	4×
Wavenumber accuracy	± 0.4 cm <sup>-1</sup>
Spectral resolution	4 cm <sup>-1</sup>
Accuracy verification	10/28/2015
Wavelength vetted on:	ICL polystyrene standard #0009-7394-0025A, thin film
Reflectance:	±2% using SRS reflectance standards 50-010-DH27B-4878



Figure 1: The Bruker 562-G integrating sphere (a) and Tensor 37 (b)

**Photographs of sample Powdered Sugar**



Figure 2: Powdered Sugar in Kroger container.

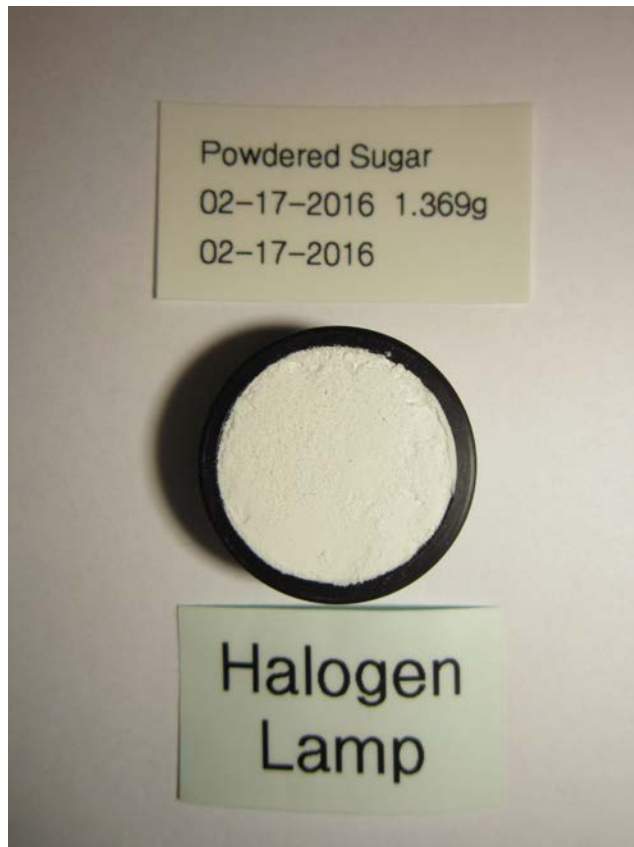


Figure 3: Powdered Sugar sample loaded in IR sample cup.

## PARTICLE SIZE PREPARATION AND CHARACTERIZATION

### Optical microscopy —

A Keyence VHX-1000 digital microscope with 16-bit resolution is used to provide photomicrographs of the various samples and particle sizes. Software included with the microscope differentiates the brightness and colors in the image and extracts the bright objects to produce a binary image. The software assumes all adjacent bright points are part of the same object then calculates the area for each of these objects. The area (A) is used to calculate the mean particle diameter (d) by assuming the particles are spherical and using the relationship  $d = \sqrt{4A/\pi}$ . Although the assumption of spherical particles is clearly not always valid, this procedure provides a reasonable estimate of the mean particle size.

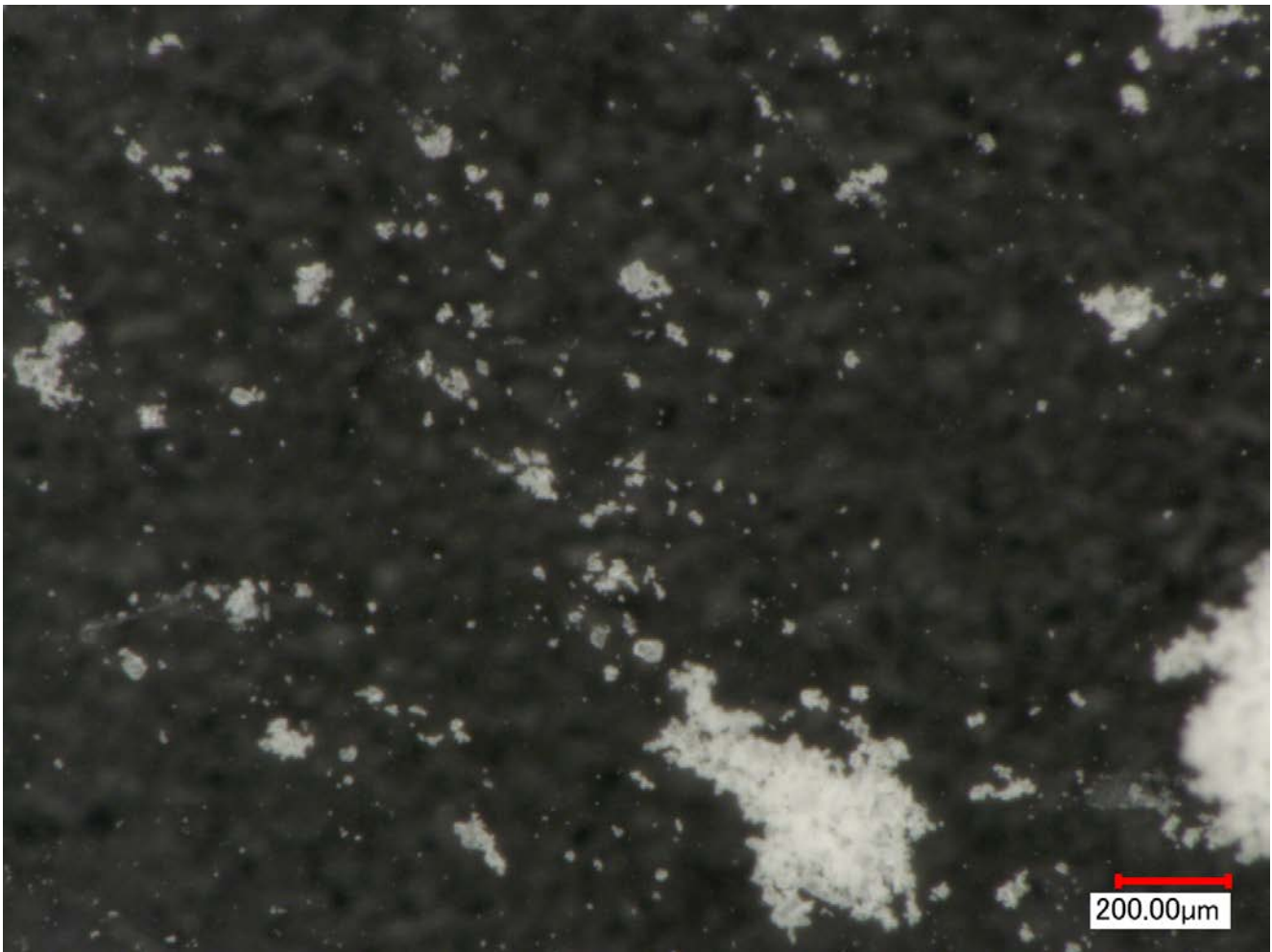


Figure 4: Photomicrograph of Powdered Sugar.

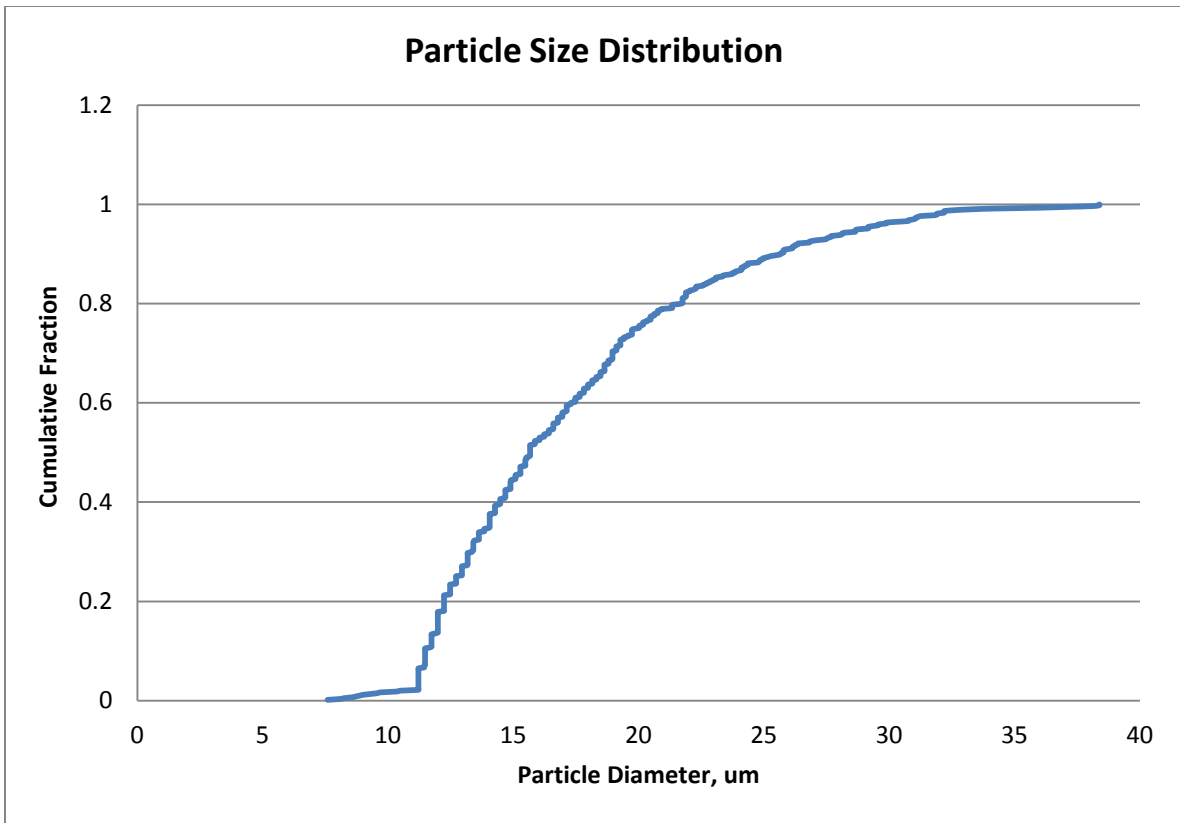


Figure 5: Particle size distribution of Powdered Sugar.