MASTER

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Particle Size Characteristics of Pyrotechnic Powders

A. A. Duncan

DEVELOPMENT DIVISION

DECEMBER 1976
(P.O. NO. 03-2530)

For
Sandia Laboratories
Albuquerque, New Mexico

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ABSTRACT

Pyrotechnic powders supplied by Al Heckes of Sandia Laboratories, Albuquerque, have been characterized using a semi-automatic microscopy technique (Zeiss Analysis) to measure particle size distribution and specific surface area by both gas adsorption (static BET apparatus) and permeametry (Fisher Sub Sieve Sizer). Photomicrographs, specific surface area and mean particle sizes are given in this report.

DISCUSSION

Pyrotechnic powders supplied by Al Heckes (Sandia) were characterized by a microscopy technique using a semi-automatic measuring device (Zeiss Analyzer TGZ-3). This technique is capable of measuring those dimensions applicable to the shape of individual particles from photomicrographs. The usefulness of many microscopy techniques is limited due to single statistical values and the inability to distinguish individual particles when agglomerated. The Pantex technique is based on the measurement of individual particles where shape decides those dimensions to be measured (e.g. if ellipsoid the major and minor axis are measured). From dimensional measurements physical parameters can be calculated for individual particles so distribution and bulk powder characteristics can be generated.

In this study, physical parameters distribution for length, width, length/width ratio, cross-sectional area, surface area, volume, equivalent circular diameter, equivalent spherical diameter, degree of sphericity and powder uniformity were calculated. From each parameter, distribution arithmetic mean values based on frequency and weight are given in Table I. Complete distribution values from which the mean values were calculated have been transmitted to Al Heckes.

Specific surface area determinations in this study were performed by gas adsorption and permeametry techniques. Gas adsorption isotherms were obtained using nitrogen as an absorbent at liquid nitrogen temperature ($\sim$ 76 K). A static system, the Micrometrics Orr Surface-Area/Pore-Volume Analyzer Model 2100D, was used for this analysis. Repeatability of this measurement is 0.02 m^2/g.

Permeametry surface area and average particle diameter were measured by the Fisher Sub-Sieve Sizer Apparatus. A series of average particle diameters are measured for each batch of material at various porosities so the proper air-flow to particle ratio may be observed. Achievement of this relationship is important so an agglomerated particle or crushed particle specific surface area is not reported. A plateau where the same average particle diameter for repeated porosity is obtained indicates proper air-flow around individual particles. Repeatability of this measurement is $\pm$ 0.005 m^2/g and 0.2 μm for average particle diameter.

Results for each batch distribution mean, standard deviation, and specific surface area are found in Table I.

FUTURE WORK

This concludes the work that was requested for these samples.

Table I. Zeiss Distribution Mean and Standard Deviation

	Frequency	Weight
Sample Identification: Palladium INCO 400, Lot PC 807		
Length (μm)	2.86	4.89
Length Std. Dev.	1.41	0.71
Width (μm)	1.62	2.65
Width Std. Dev.	1.83	0.84
Length/Width Ratio	1.76	1.86
Cross-Sectional Area (μm^2)	4.55	13.46
Surface/Particle (μm^2)	19.60	60.52
Volume (μm^3)	8.07	35.19
Equivalent Circular Diameter (μm)	2.15	3.89
Equilvalent Spherical Diameter (μm)	2.00	3.63
Degree of Sphericity	0.84	0.80
Powder Uniformity	4.78	5.79
Zeiss Specific Surface Area (m^2/g)	2.025	
BET Specific Surface (m^2/g)	1.415	
Sample Identification: Palladium Englehard PD-325 Mesh		
Length (μm)	2.18	6.07
Length Std. Dev.	1.43	4.03
Width (μm)	1.68	3.42
Width Std. Dev.	0.65	1.74
Length/Width Ratio	1.24	1.67
Cross-Sectional Area (μm^2)	3.80	26.40
Surface/Particle (μm^2)	15.49	115.05
Volume (μm^3)	7.36	120.34
Equivalent Circular Diameter (μm)	1.94	4.89
Equivalent Spherical Diameter (μm)	1.88	4.57
Degree of Sphericity	0.96	0.87
Powder Uniformity	5.96	3.98
Zeiss Specific Surface Area (m^2/g)	0.175	
BET Specific Surface (m^2/g)	0.185	
Sample Identification: Titanium Powder Alpha Product No. 99612 Lot 08057		
Length (μm)	5.90	8.67
Length Std. Dev.	2.60	4.57
Width (μm)	4.98	5.99
Width Std. Dev.	0.91	1.96
Length/Width Ratio	1.17	1.41
Cross-Sectional Area (μm^2)	25.60	51.96
Surface/Particle (μm^2)	101.30	222.16
Volume (μm^3)	97.75	319.71
Equivalent Circular Diameter (μm)	5.42	7.42
Equivalent Spherical Diameter (μm)	5.30	7.09
Degree of Sphericity	0.97	0.92
Powder Uniformity	10.94	6.86
Zeiss Specific Surface Area (m^2/g)	2.300	
BET Specific Surface (m^2/g)	3.270	

Table I. Zeiss Distribution Mean and Standard Deviation (Cont'd)

Sample Identification: Boron Callery 2903-72-3 CCC 951299

	Frequency	Weight
Length (μm)	1.13	2.00
Length Std. Dev.	0.59	0.86
Width (μm)	0.73	1.14
Width Std. Dev.	0.26	0.43
Length/Width Ratio	1.51	1.77
Cross-Sectional Area (μm^2)	0.80	2.49
Surface/Particle (μm^2)	3.42	11.39
Volume (μm^3)	0.60	3.10
Equivalent Circular Diameter (μm)	0.91	1.64
Equivalent Spherical Diameter (μm)	0.86	0.90
Degree of Sphericity	0.90	0.81
Powder Uniformity	6.31	5.41
Zeiss Specific Surface Area (m^2/g)	24.530	
BET Specific Surface (m^2/g)	30.520	

Sample Identification: Aluminum -325 Mesh Job No. 5647
MRC-Mare Part No. 586700X01

	Frequency	Weight
Length (μm)	18.29	34.49
Length Std. Dev.	10.54	14.25
Width (μm)	9.69	16.98
Width Std. Dev.	3.86	7.30
Length/Width Ratio	1.84	2.10
Cross-Sectional Area (μm^2)	172.58	626.19
Surface/Particle (μm^2)	686.02	2580.01
Volume (μm^3)	1685.73	10344.39
Equilvalent Circular Diameter (μm)	13.20	25.88
Equilvalent Spherical Diameter (μm)	11.88	22.98
Degree of Sphericity	0.86	0.79
Powder Uniformity	5.65	4.81
Zeiss Specific Surface Area (m^2/g)	0.150	
BET Specific Surface (m^2/g)	0.360	