



Designation: B 923 – 02

## Standard Test Method for Metal Powder Skeletal Density by Helium or Nitrogen Pycnometry<sup>1</sup>

This standard is issued under the fixed designation B 923; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This test method covers determination of skeletal density of metal powders. The test method specifies general procedures that are applicable to many commercial pycnometry instruments. The method provides specific sample outgassing procedures for listed materials. It includes additional general outgassing instructions for other metals. The ideal gas law forms the basis for all calculations.

1.2 This test method does not include all existing procedures appropriate for outgassing metal materials. The included procedures provided acceptable results for samples analyzed during an interlaboratory study. The investigator shall determine the appropriateness of listed procedures.

1.3 This method uses SI units as standard according to Practice E 380. State all numerical values in terms of SI units unless specific instrumentation software reports volume and/or density using alternate units. In this case, present both reported and equivalent SI units in the final written report. Many instruments report skeletal density as  $\text{g/cm}^3$  instead of using correct SI units ( $\text{kg/m}^3$ ).

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:

- B 215 Practices for Sampling Finished Lots of Metal Powders<sup>2</sup>
- B 243 Definitions of Terms Used in Powder Metallurgy<sup>2</sup>
- E 380 Practice for Use of the International System of Units (SI)<sup>3</sup>
- E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method<sup>3</sup>

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee B09 on Metal Powders and Metal Powder Product and is the direct responsibility of Subcommittee B09.03 on Refractory Metal Powders.

Current edition approved Oct. 10, 2002. Published December 2002.

<sup>2</sup> Annual Book of ASTM Standards, Vol 02.05.

<sup>3</sup> Annual Book of ASTM Standards, Vol 14.02.

### 3. Terminology

3.1 Definitions—Refer to Terminology B 243 for additional definitions relating to metal powders.

3.2 *Definitions:* Definitions of Terms Specific to This Standard:

3.2.1 *density, n*—the mass per unit volume of a material.

3.2.2 *density, skeletal, n*—the ratio of mass of discrete pieces of solid material to the sum of the volumes of the solid material in the pieces and closed (or blind) pores within the pieces.

3.2.3 *outgassing, n*—the evolution of gas from a material in a vacuum or inert gas flow, at or above ambient temperature.

3.2.4 *skeletal volume, n*—the sum of the volumes: the solid material in the pieces and closed (or blind) pores within the pieces.

### 4. Summary of Test Method

4.1 An appropriately sized sample (to provide at least the minimum skeletal volume required for reliable results for the instrument or apparatus used) is outgassed under appropriate conditions prior to analysis.

4.2 The sample is weighed to nearest 0.1 mg. It is important to use an analytical balance to determine the sample mass. The pycnometer measures the total displaced skeletal volume of the sample under analysis. The sample mass is then used to calculate the skeletal density of the metal. Any error in the sample mass will affect the calculated density. Some cleaning of the sample surface may take place inside the pycnometer. Therefore, it is best to reweigh the sample after analysis and use the final mass when calculating skeletal density.

4.3 Sample skeletal volume is determined a minimum of five times. Skeletal volume average and standard deviation are calculated using standard statistical methods.

4.4 Calculations are based on the ideal gas law, as required by the instrument being used for the determination. The assumption of ideal behavior is accepted as valid at analytical temperatures and pressures. For instruments designed with two pressure chambers, one a sample compartment, and the other a gas expansion chamber, the equation for sample volume calculation takes the form: