



Density Solutions: Ceramics Structural Materials

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T rue (skeletal) density is best determined by automatic gas expansion pycnometers; there are no solubility issues, solvent disposal problems, or density limitations as might be encountered with liquid pycnometers and/or flotation (buoyancy) devices. Density is an intensive property of solids, i.e. it does not depend on the quantity of the material, and as such can be used to confirm phase purity, study the densification process during sintering and indicate presence of closed porosity. True and apparent density measurements such as these are, therefore, very widely used in the ceramics and glass industries, for everything from clay powders and binders to catalyst supports, ferrites, aerospace materials, even refractory bricks.



Density measurements are a good place to start when investigating product failure.

Automated Preparation and Analysis

The basis of gas expansion pycnometry is known to most high school students: Boyle's Law, most often stated as $P_1V_1 = P_2V_2$. Modern pycnometer technology has elevated this apparently mundane measurement into a rapid research and quality tool. Sample preparation, removal of adsorbed vapors and displacement of atmospheric gases is done automatically as part of the analysis protocol. Quantachrome's Ultrapycon (shown above) features three modes of purging the sample chamber, by timed flow, a number of pressurization/depressurization cycles called pulses, or timed evacuation. Repeated measurements are initiated immediately upon completion of the purge cycle, and are continued until some user-defined repeatability is met. This programmable parameter eliminates operator subjectivity as to when to end a series of measurements, and includes calculation and reporting of a mean value averaged over three or more readings plus its associated standard deviation.

Multiple Sample Pycnometer

Maximal accuracy is ensured by having a variety of different sized sample holders available for use in a

single pycnometer, Quantachrome's Pentapyc 5200e, for example, stores up to fifteen calibration values in memory for use with its five sample stations and three chamber sizes. One should be careful to realize that pycnometers truly measure volume, and the density result is only as



Multiple-sample pycnometers (such as Quantachrome's Pentapyc 5200e) dramatically reduce operator time.

good as the weight value used for any given sample. Transcription and button-push errors are eliminated by using the built-in balance interface (communication) port. And although fully standalone via keypad, display and printer connection, these automatic pycnometers are available with PC software for control and reporting.

21st Century Technique

Modern pycnometers are appropriate for powders and monolithic pieces, core samples, even slurries. Their small footprint, low gas consumption and zero-solvent usage allow them to be used easily in confined laboratories or wherever bench space is at a premium. Temperature controlled and remote operation versions are available for the most demanding applications. Accuracy and precision within 0.02% can be achieved. Pycnometry has come a long way since the time of Archimedes, so perhaps now is a good time to upgrade from density bottles. When was the last time you saw a Chapman, Kohlrausch or le Chatelier flask with balance and printer ports?

For more information about instruments to measure density, porosity and related properties, contact Quantachrome Instruments by phone (561) 731-4999, fax (561) 732-9888, email: qc.sales@quantachrome.com.

Particle Size Analysis?

Is the entire size distribution represented in the small scoopful you just put into your analyzer? Probably not, unless you split the original sample on a **Rotary Micro Riffler**®.

Quantachrome offers two rifflers, both eight-way splitters, one for larger bulk samples which includes built-in sieving action, and the smaller **Rotary Micro Riffler**® (shown) which uses regular test tubes.

Reduce variability in your particle size results... make your next sample a representative one.



To ask about Quantachrome rifflers, email: qc.sales@quantachrome.com for more information.

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Porosity Changes Explained.

The **PoreMaster**® GT uses the extremely effective rapid mercury intrusion technique. With automatic pore size and pore volume distribution analyzers, you will never have porosity inconsistency in your products again.

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PoreMaster® GT

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Three Operating Modes:

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