# Ultrasonics Power Lab-Size Spray Dryer

*Compact, easy-to-clean unit designed and built at New Mexico Tech accepts very small slurry samples. The granules are a good approximation of what can be expected when the spray drying process is scaled up*

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Laboratory scale processing of small samples of ceramic slurries into granules suitable for dry or isostatic pressing could be enhanced by a spray dryer having these features:

- Compact size.
- Usable with very small amounts of slurry.
- Minimum material loss and ease of cleaning.
- Capable of producing granules of the same size and shape as those that will result when the process is scaled up.

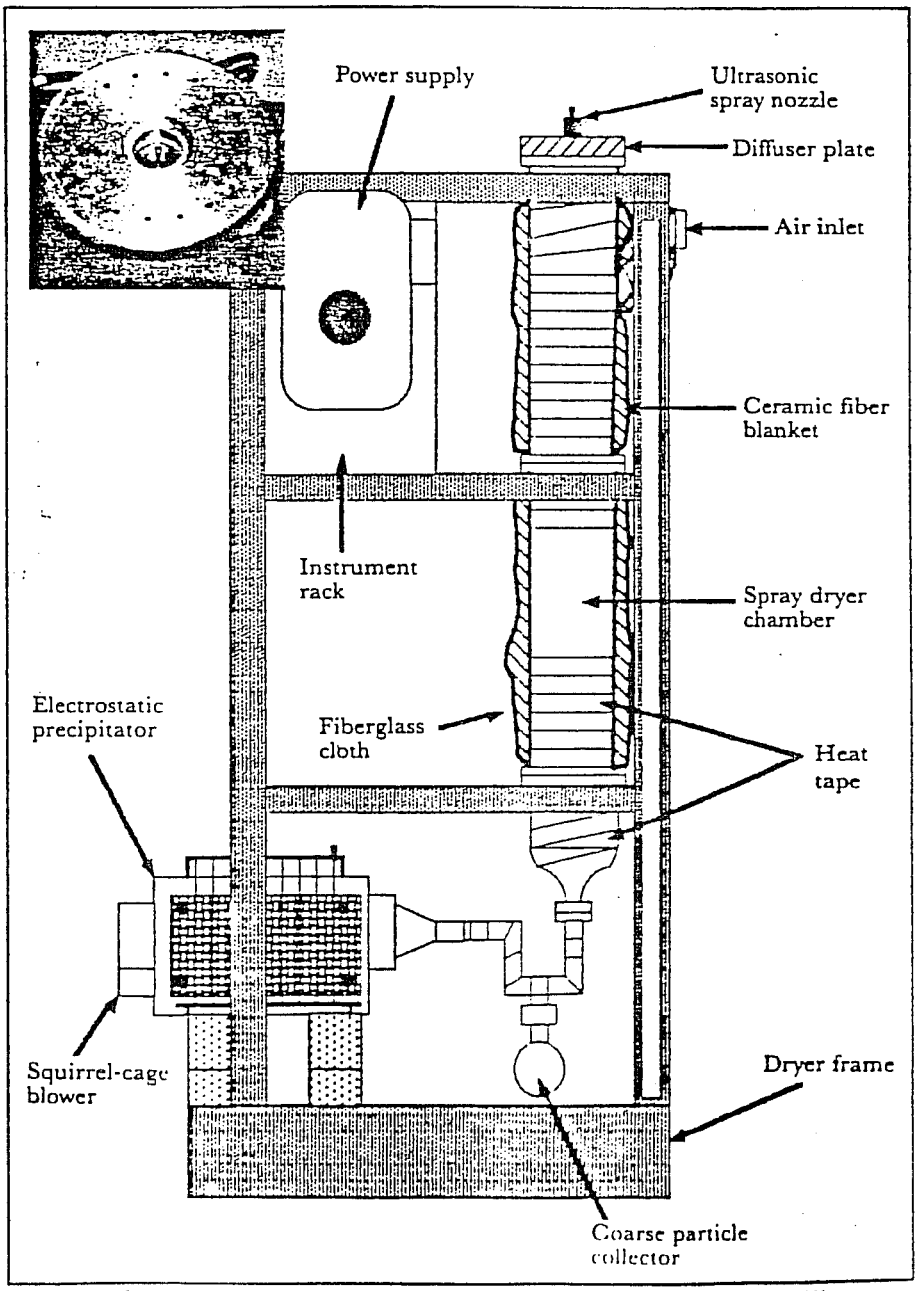
A spray dryer that satisfies these criteria has been developed and tested at New Mexico Tech. The system was designed around a commercially available ultrasonic atomization nozzle.

**Choosing the atomization method**

Ultrasonic atomization was selected over competing methods for several key reasons.

The requirement for compactness effectively eliminated such alternatives as rotating disks or two fluid sprayers that impart high velocities to the droplets. High droplet velocities require that either the dryer's diameter or height be large so that the droplets will be dry when they impact the wall, and not splatter or deform. And, because ultrasonic atomization does not require a gaseous propellent, the added bulk, complexity and potential for product contamination associated with compressor systems are eliminated.

Droplets formed with low velocities, as in ultrasonic atomization, can drift under the influence of gravity down a chamber having its long dimension vertically oriented. This chamber can have a small diameter, and its height need



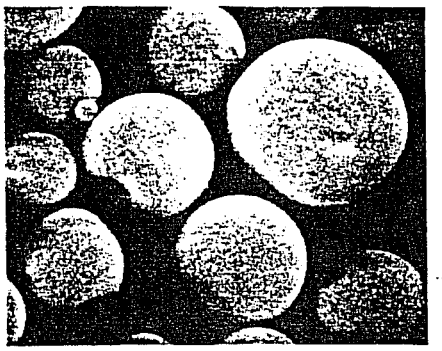

*Schematic of New Mexico Tech's ultrasonic spray dryer. Inset shows bottom view of diffuser assembly with ultrasonic nozzle at its center.*

...ly be sufficient to ensure that droplets are dry when they reach the bottom collection area. Thus, contact between droplets and chamber walls is minimized, and wall cleaning requirements are reduced.

Ultrasonic atomization does not depend on forcing liquid through small apertures. This means that the liquid outlet can be large compared with that of a pressure nozzle, which is prone to clogging.

Another advantage of ultrasonic atomization is that it requires little power—typically no more than 10 W. This is several orders of magnitude less than that consumed by hydraulic or air-atomizing pressurized systems which utilize energy-intensive pumps or compressors. Therefore, only a simple low-pressure peristaltic pump is needed to transfer slurry to the ultrasonic atomization nozzle.

Note that the same atomization nozzle can be used for slurry flow rates from near zero to rated capacity. This is a very attractive feature in a lab-size spray dryer.



*SEM photomicrographs (500×) of coarse-fraction alumina granules from run C. The spray-dried granules appear to be very suitable for dry or isostatic pressing.*

Finally, droplet size in ultrasonic atomization is primarily a function of nozzle vibrational frequency: low frequencies yield larger droplets. Therefore, it is possible to scale up the spray dryer and retain the same particle size distribution. This feature is particularly important if the dryer is used in a pilot operation, and the goal is large-scale production.

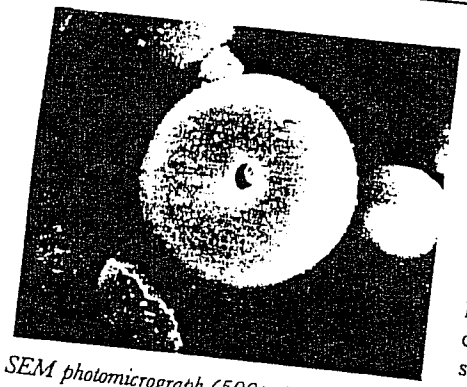
### Spray dryer design features

The slurry sample is held in a small glass beaker equipped with a magnetic stirrer. A small pump and flexible plastic hose transfer the slurry into the ultrasonic atomization nozzle. The nozzle is mounted at the center of a gas (air) diffuser. The nozzle-diffuser assembly is clamped and sealed to the top of a Pyrex-type glass pipe, 6 in. in diameter. Additional air can be introduced to the dryer via a 2 in.-diameter Y-fitting.

The ultrasonic nozzle creates a "mist" of droplets that falls to the bottom of the chamber where "coarse-fraction" granules are collected. The vapor-laden air is exhausted at low velocities by a small squirrel-cage fan. Spray-dried granules too small to be collected are captured by an electrostatic precipitator.

Heat for the dryer's main chamber is provided by glass-insulated resistance heating tape.

In an earlier dryer design, air was preheated in a small external oven and blown through the diffuser into the chamber. A high air velocity was needed to ensure proper drying of



*SEM photomicrograph (500×) of crushed granules reveals dense, solid structure.*

slurry droplets. However, the high airflow caused a vortex to form near the nozzle tip, which deflected some droplets up into the diffuser. It also created an uneven distribution of air exiting the diffuser, which deflected other droplets toward the chamber wall.

The low flow of air through the current unit's diffuser does not disturb the downward motion of the slurry mist plume. The glass Y-fitting adds just enough room air to properly dry the droplets without appreciably deflecting them toward the chamber wall.

The insulated chamber's outside diameter is slightly larger than 8 in., and the entire unit stands just 6 ft tall. The dryer is mounted in a roll-around instrument rack. Cleaning is easy: the dryer is positioned over a floor drain.

A small fraction of the granules are doughnut-shaped. This type of defect can lead to flaws in green or sintered bodies unless the granule is completely crushed during pressing. We also have observed the defect (often in large numbers) in granules made by other atomization methods.

Steps that could be taken to eliminate hollow granules include lowering the chamber temperature, increasing the slurry's solids loading, moderating nozzle voltage and power levels, and increasing the nozzle's vibrational frequency to reduce droplet size. ☐

For more information on New Mexico Tech's ultrasonic spray dryer, contact the authors directly by letter or telephone at Materials Research Center, New Mexico Institute of Mining & Technology, Socorro, N.M. 87801; tel: (505) 835-5646.