

## NANO HIGHLIGHT

### *Fluidization of Silica Nanoparticles Using External Forces*

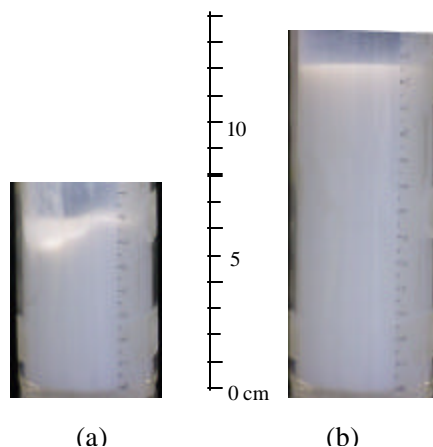
**NIRT Grant 0210400**

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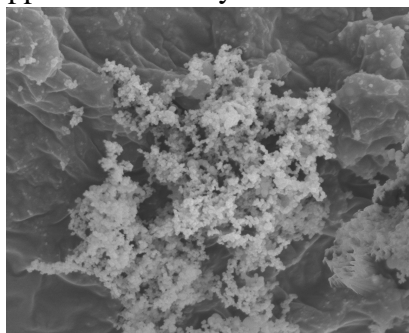
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Fluidization is widely used in powder processes due to its continuous powder handling ability, good fluid-solid contacting, high heat and mass transfer coefficients, and high rates of reaction. However, particles smaller than 20 microns are commonly very difficult to fluidize since these powders will generally form channels, “rat holes” or lift as a solid plug when exposed to the fluidizing medium.

Researchers at New Jersey Institute of Technology have found that coupling aeration with vibration, acoustic waves, or centrifugal force dramatically enhanced and improved the fluidizability of a variety of cohesive nanopowders, reducing the velocity needed for fluidization, eliminating plug formation, “rat holing,” and spouting. Smooth, homogeneous, virtually bubbleless fluidization with negligible elutriation resulted. Typical photographs of aerated beds (a) without vibration and (b) with vibration are depicted in the side figure. It has been found that fluidization of nanoparticles is possible due to the formation of large, stable, highly porous agglomerates. A high resolution SEM image of a silica nanoagglomerate is shown below.



Experimental studies using the three different external forces with various nanoparticles were conducted. The general behavior of the bed, minimum fluidization velocity, pressure drop across the bed, bed expansion, as well as the different parameters important to each external field applied were analyzed. A theoretical analysis based on fractal theory and the Richardson-Zaki relationship for liquid fluidization has been successful in predicting the size and voidage of the highly porous fluidized agglomerates. Silica nano- particles were also successfully fluidized in the form of porous agglomerates in a two-story vertical riser at Illinois Institute of Technology, which can simulate the circulating fluidized beds used in large-scale industrial applications.



In comparison to conventional fluidized beds, the advantages of using external forces include much lower minimum fluidization velocities, significantly reduced elutriation, and the ability to control the occurrence and size of bubbles. These findings have led to important progress towards understanding the processing of nanoparticles and nanocomposites that will be used to develop exciting new applications in nanotechnology.

#### References

Robert Pfeffer, Rajesh N. Dave, Chao Zhu, New Jersey Institute of Technology, Grant Number 0210400.