# A method to prepare size-controlled spherical nano/micro particles by pulsed laser ablation using inertial effects


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Pulsed laser ablation in a background gas is known as one of the methods to grow nanoparticles from the gas phase. Usually, droplets are simultaneously ejected from the target, and undesired irregularly shaped particles are deposited on the substrate. However, spherical particles can be prepared if the molten droplets are controlled to solidify before deposition. We show a simple method to deposit size-selected spherical nano/micro particles from droplets on the substrate using a pipe and gas flowing through the pipe.
The experimental setup is shown in Fig.1. Silicon, germanium, titanium dioxide, copper, silver and gold were used as targets. Helium gas was introduced in the chamber, and the gas flow velocity was controlled by MFC. The nanosecond pulsed YAG laser was used for ablation. The particles ejected from the target by laser irradiation travel with gas flow through a pipe to the substrate. The deposited materials are observed by SEM.
A SEM image of silicon spheres prepared at a gas flow velocity of 13 m/s is shown in Fig.2. The deposited materials were spherical particles with narrow size distribution; the geometric standard deviation was about 1.1~1.3. The mean diameter as a function of gas flow velocity is shown in Fig.3 as triangles and circles for silicon and copper, respectively. The mean diameter can be varied from tens of nm to a few μm by controlling gas flow velocity, as shown in Fig.3. The lines in the figure are the result of calculations based on the theory of inertial impaction on the substrate[1]. The agreement between the experimental results and calculation is good, not only for the silicon and copper but also for the other target materials, germanium, titanium dioxide, silver, and gold.
In conclusion, spherical nano/micro particles can be prepared by using a pipe and gas flow. The mean diameter can be varied by controlling the gas flow velocity and can be estimated prior to the deposition by a calculation based on the inertial impaction theory.

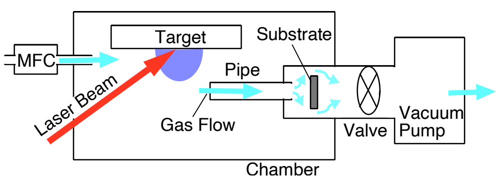


Fig.1 Experimental setup

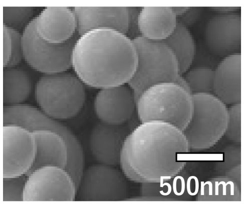


Fig.2 SEM image

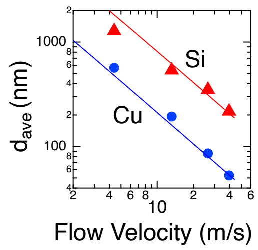


Fig.3 The mean diameter vs. gas flow velocity


**References**: [1] W. C. Hinds, *Aerosol Technology* (Wiley-Interscience, 1999)