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Particles synthesis via atmospheric-pressure plasma with solution microdroplets

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Synthesis of sub-micrometer-diameter particles via atmospheric-pressure plasma with solution microdroplets will be demonstrated with two plasma-microdroplets systems.

The first system is with helium dielectric-barrier discharges and mist generated with an ultrasonic oscillator (Fig. 1), in which diameters of each microdroplet vary widely with its average of 5 μm [1,2]. The second system is with radio frequency argon plasma and microdroplets generated by an inkjet system (Fig. 2), where reproducibility of droplet diameter was within 1-2% with its diameter of approximately 20 μm in our current system [3]. While similar system with atmospheric-pressure plasma and an inkjet head has been applied for plasma-assisted inkjet printing [4–6], different generation method of plasma with higher input power as well as longer traveling distance of droplet are applied for complete evaporation of droplet during its flight.

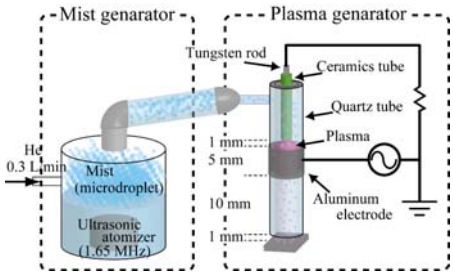

Fig. 1 Experimental setup with mist plasma [1].

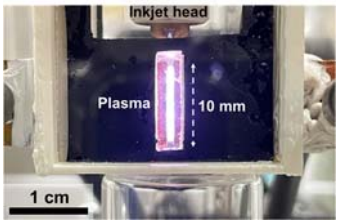

Fig. 2 Experimental setup with an inkjet system [3].

With the first system with mist, ZnO spheroidized particles (SPs) with a unique nanocomposite structure, in which crystalline wurtzite nanoparticles are surrounded by an amorphous matrix, were synthesized from zinc acetate ($Zn(Ac)_2$) solution. Their diameters can be controlled by adjusting the concentration of the solution, while the size of the ZnO particles vary widely (Fig. 3), probably because of wide size distribution of the mist droplets [3].

With the second system with inkjet droplets, gold spheroidized particles were synthesized from chloroauric acid ($HAuCl_4$) solution. Their diameters can be also controlled by adjusting the concentration of the $HAuCl_4$ solution, demonstrated here for sub-micrometer range. The sub-micrometer gold particles synthesized with the inkjet system have a very narrow size distribution (3–9% standard deviation), as shown in Fig. 3.

Further details as well as recent progress of the plasma-inkjet system will be presented at the conference.

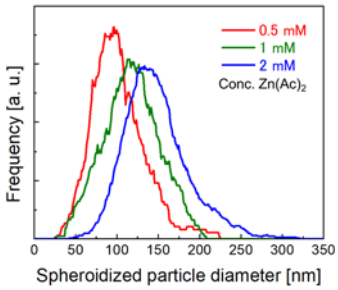

Fig. 3 Size distribution of synthesized ZnO particles [1].

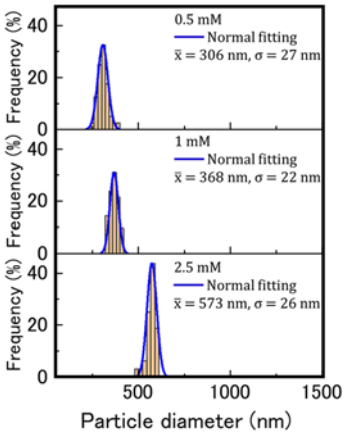

Fig. 4 Size distribution of the synthesized Au particles [3].

References

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