הטכניון - מכון טכנולוגי לישראל

TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

הפקולטה להנדסה כימית
ע"ש וולפסון
The Wolfson Department of Chemical Engineering

Wolfson Department of Chemical Engineering Seminar
Lecture Hall 6, Wolfson Department of Chemical Engineering,
Wednesday April 17th at 1:30pm

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Engineering and Synthesis of Nanomaterials Using Submicron Droplet Aerosols

This talk will discuss the research on aerosol nanotechnology performed by the speaker. In technologies like spray drying and aerosol particle synthesis a need for sprays and aerosols with very fine droplets was recently recognized. To address this challenge, the author developed an original technique for liquid atomization and production of aerosols consisting of submicron-size droplets. Measurements with laser diffraction demonstrated that generated water droplets were ~200 nm in mean diameter, which is 10-100 times smaller than the mean droplet size in conventional liquid atomization systems. The properties of new liquid atomization technique were systematically studied by atomizing different liquids, including water, fuels (gasoline and diesel), aqueous solutions of various salts (sodium and calcium chlorides, sodium alginate) and others. The analysis of the experimental data allowed identifying a dimensionless parameter not previously described in the literature, which plays a primary role in the new aerosol production process, and establishment of a semi-empirical model.

The substantial reduction in droplet size offered by the new atomization method promotes very fast evaporation of solvent and, for aerosol particle synthesis, enables formation of submicron particles even in the limit of room temperature drying conditions, as it was demonstrated by the author for sodium chloride and silica and titania xerogel particles. On the other hand, ultra-fine diameters of the generated droplets enable the usage of more concentrated precursor solutions, e.g. ten or even one hundred times, to obtain the same final particle size as conventional spray/aerosol particle synthesis systems. Additional advantages of the system were found by the author when flame aerosol synthesis of phosphor (Y_2O_3:Eu^{3+}) and NMC ($LiNi_{1/3}Mn_{1/3}Co_{1/3}O_2$) particles was performed. Microscopic analysis of the particles synthesized in flame revealed considerable differences in final particle size distribution as well as in particle morphology and in surface structure when submicron (novel system) and micron-size (conventional ultrasonic nebulizer) droplets were utilized. Moreover, novel particle coating system employing submicron droplet aerosols was recently demonstrated: γ-Al_2O_3 and cellet particles suspended in a fluidized bed were coated by sodium benzoate, and coating thickness on particles was as small as few microns (versus tenths of microns for regular spray), while the yields was ~30%, and the microstructure of coating layers produced by submicron and micron-size spray droplets had noticeable differences in terms of smoothness and porosity.

The simplicity, versatility, scalability, cost-efficiency and other benefits of the new aerosolization and particle synthesis system, which have been demonstrated so far, make it prospective for science and technology in chemical, biotechnological, pharmaceutical, energy, materials, biomedical, environmental and other application areas.

Refreshments will be served at 1:15pm