2017 ALKIVIADES PAYATAKES DISTINGUISHED LECTURE

Aerosol Science and Technology for Industrial Applications -Aerosol Filtration and New Material Synthesis-

Kikuo Okuyama

Department of Chemical Engineering, Graduate School of Engineering, Hiroshima University, Kagamiyama 1-4-1, Higashi-Hiroshima, 739-8527 Japan

Abstract

Various functional nanoparticles and fibers with a diameter less than 100nm are now available for practical applications such as catalytic, electronic, optic, magnetic, cosmetic, and drug materials. To further increase functionality, control of size, morphology, etc. is now of great interest. In this lecture, after briefly introducing the dendritic aerosol deposition in fibrous filters under the guidance by Prof. Payatakes at the Univ. of Houston, (1) synthesis of controlled nanofiber mat for aerosol filtration, and (2) nanoparticle synthesis, dispersion and nanostructurization, will be introduced from our recent research.

On the first subject, polymer nanofiber mats with various morphologies (nanofibers, beaded-nanofibers and composite particles/nanofibers) were prepared by electrospinning method. The filtration performance of various polymer nanofiber mats was evaluated based on the quality factors. The importance of morphology optimization of polymer nanofiber was suggested. By adding the cellulose nanofibers into a polymer solution, dual-sized cellulose-polymer nanofiber composite with large surface area was prepared and its availability for filter application was examined. Using the air filter of nanofibers down to the diameter of 40 nm, the effect of slip flow on filter efficiency and pressure drop was discussed. These basic ideas are applied to the synthesis of commercially available high performance PTFE filters.

On the second subject, in aerosol material processing such as plasma synthesis, flame synthesis, the produced nanoparticles tend to take forms of agglomerates, aggregates or heavily sintered aggregates due to high-temperature field. Accordingly, dispersion with disintegration of these agglomerated/aggregated nanoparticles into isolated nanoparticles in liquid is extremely important for various applications. From our recent research, use of a new type of bead-mill with smaller ZrO_2 beads is effective to disperse agglomerated nanoparticles without damaging. Synthesis of Fe/Al_2O_3 nanoparticles via plasma process for the rare earth free magnetic $Fe16N_2/Al_2O_3$ nanoparticles will be explained. The nanoparticles can act as building blocks for the construction of functional structures, such as highly ordered aggregates, as well as porous and hollow aggregates. Highly ordered nanostructures of SiO_2 using spray drying method and self-organized nanostructured hollow and porous carbon particles using spray pyrolysis method will be introduced as well.

Finally, our recent joint research project with industry will be briefly introduced.