Nanocrystalline Alumina Synthesized with Use of Egg Whites

Nanocrystalline ceramic particles are often prepared using sol-gel techniques, wherein precursor solutions containing metal ions are transformed to an amorphous gel by a change in the pH, temperature, or ionic strength of the solution. S. Dhara of the Materials Science Centre at the Indian Institute of Technology in Kharagpur has demonstrated a novel approach to sol-gel processing. Rather than producing the gel by treating the precursor solution, the metal nitrate is dispersed in an aqueous matrix of egg whites (ovalbumin). Heating this simple mixture leads to well-crystallized, nanosized powders of γ-alumina.

As reported in the July issue of the *Journal of the American Ceramic Society* (p. 2003; DOI: 10.1111/j.1551-2916.2005.00382.x), the amorphous gel was formed by first mixing fresh egg whites in water, then adding aluminum nitrate dropwise to obtain a 3:2 ratio of $Al(NO_3)_3$ precursor-to-ovalbumin solution. The mixed solution then is allowed to gel by resting for 2 h and is subsequently dried for 10 h at 80–150ºC. The result is a yellowish mass that is then crushed into a fine powder.

X-ray diffraction (XRD) analysis showed that the powder is initially amorphous and that 2 h heat treatments crystallized the material into γ-alumina. Crystalline alumina peaks were observed for annealing temperatures as low as 330ºC, although diffracted peak intensities increase at higher temperatures. These results were supported by differential thermal analysis (DTA) curves showing exothermic peaks at 330ºC, 560ºC, and 630ºC. These peaks indicated crystallization of the precursor and subsequent degradation of the ovalbumin.

Particle size analysis using XRD and transmission electron microscopy (TEM) confirmed that these powders are nanocrystalline. Crystallite sizes were estimated to be in the range of 15–25 nm using the Debye–Scherrer formula for x-rays and in the range of 15–80 nm from TEM micrographs. Thus, said Dhara, ultrafine ceramic particles can be obtained from a gel matrix of metal ions dispersed in an aqueous solution of egg whites.

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SB Explains CNFET Performance Dependence on Diameter and Metal Contact

Due to exceptional electrical properties and high carrier mobility, there has been significant interest in exploring the potential of carbon nanotubes (CNTs) as building blocks in future applications of nanoelectronics, such as the use of carbon nanotube field-effect transistors (CNFETs) as Schottky Barrier (SB) devices. However, CNFETs have yielded large on-current (I_{on}) variations ranging from 10^{-5} A to 10^{-8} A with similar device geometries, and there has been no clear conclusion as to the origin of these variations. Recently, Z. Chen from the IBM T.J. Watson Research Center in New York, J. Knoch from the Institute of Thin Film and Interfaces and the Center of Nanoelectronic Systems in Jülich, Germany, and their colleagues have demonstrated that the optimum performance of the CNFET devices depends upon a combination of the diameter of a single-walled CNT and the type of metal contact and have produced a model that accounts for the observed current variations.

As reported in the July issue of *Nano-Letters* (p. 1497, DOI: 10.1021/n10508624), the researchers fabricated over a hundred