PREPARATION OF MONOSIZED SPHERICAL MICRO-PARTICLES AND APPLICATION FOR A TERAHERTZ PHOTONIC CRYSTAL

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Small particles having the same size, often called as monosized powder, have now been finding increased needs in a number of scientific fields. Latex particles produced by sol-gel process are well known as monosized particles. For the semiconductor industry, spherical solder particles whose particle size is around 100-300μm have been required for electronic packaging of LSI chips and their devices. The concept of spherical semiconductor has a potential to revolute the electronic industry because it has three times surface area of a conventional flat chip and point symmetrical geometry without edge. The advantages provide unique applications such as high-efficiency spherical solar cell and three-dimension integrated circuit ball. At present, the production processes of monodisperse powders include sol-gel process for oxide particles, plasma rotating electrode process (PREP), and sieving atomized powders. However, the size of the particles produced by sol-gel process is limited in the range 0.1 to 0.2μm ; in the PREP method, the critical particle size is about 100μm due to the limitation of the rotating stability of the electrode. Fabrication of spherical semiconductor particles have been attempted by various methods, which almost all involve an idea of containerless solidification. For instance, the electromagnetic levitation methods and the drop-tube methods have been frequently employed to obtain the semiconductor particles, where the size control is limited to a millimeter order. Thus, alternative methods, which are capable of producing powders controlled in any desired size, have been demanded for the extension of applying fields of monosized powders.

This paper describes the preparation of monosized spherical particles of metals and semiconductor materials by means of the newly developed pulsated orifice ejection method. The apparatus allows to prepare particles having very narrow particle size distribution where standard size deviation is less than 2% of mean particle size. No sieving process is required because of the direct preparation method. The method offers desired size control because particle size is nearly equal to orifice diameter. For an unprecedented application, three-dimensional artificial crystals with periodicity corresponding to terahertz wavelengths were fabricated by self-assembling monosized metal spherical particles. The metal crystals were weakly sintered to utilize them as templates. The metal templates were inverted to air spheres crystal embedded in dielectric resin through infiltration and etching. The resulting resin inverted crystals clearly presented the photonic stop gaps within terahertz wave region and the frequencies of the gaps were confirmed to agree well with calculation by plane wave expansion method.