Analysis of singular phenomena and production of novel material in nano-region

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Clusters and fine particles possess singular phenomena that are extraordinary compared with the nature of the bulk material. Owing to their unique phenomena, such as coalescence growth, characteristic external form, new crystal structure and spontaneous alloying, it is important to clarify the material-dependent phenomena and their physics.

In addition to the carbon allotropes of graphite and diamond, fullerenes with mixed sp^3/sp^2-hybridized carbon and carbines with mixed sp^3/sp-hybridized carbon are materials of increasing interest.

Thin carbon films prepared by vacuum evaporation were irradiated by white synchrotron radiation beam. Growth of small carbyne crystals in a thin amorphous carbon film has been observed by high-resolution transmission electron microscopy. The as-deposited film was composed of diamond and graphite crystallites of size 1 nm. Circular α-phase carbyne crystals predominantly grew to 20 nm in size and transform into (α+β)-phase crystals with an elongated shape of 100 nm in length. The growth process of carbyne crystals has been discussed in terms of selective excitation of graphite crystallites by an SR beam.

On the other hand, the spontaneous alloying phenomena have been observed and are believed to occur only in metallic clusters. In the present paper, it has been noticed that the spontaneous mixture occurs even in alkali halide systems at 200nm size that is a hundred time larger than metallic alloy system. Therefore, the spontaneous mixing phenomenon of alkali halide clusters were performed systematically by the successive evaporation of different alkali halides on carbon substrates. It became evident that the limit of mixing was governed by the ratio of ionic radii. If the ratio of ionic radii between the cation and/or anion was more than 68 %, intermixing occurred. If four different elements of cations and anions are involved, two mixture phases grew. The key elements of mixing were the nearest ionic radii.