IV 族ナノクラスタ固体の構造と物性 東北大学大学院理学研究科 物理学専攻 谷垣勝己

Structure and Properties of IV-Group Cluster Crystals

Recent progresses on science and technology of clusters have resulted in a surge of interests in materials science. In this lecture, nano size materials comprised from IVth-group elements of C, Si, Ge and Sn, are presented and new insights to fundamental understanding in physical/chemical phenomena and properties, as well as development of advanced electronic devices, are discussed. The most typical cluster is C₆₀, where sixty carbon atoms are self-assembled to a soccer ball shaped polyhedral cluster with Ih high symmetry. Moreover, the other IVth -group elements like Si, Ge and Sn have recently been noticed to make similar polyhedra of (IV)₂₀, (IV)₂₄ and (IV)₂₈ cage clusters. One of the prominent things on these large size clusters is the fact that various types of crystals can be constructed ranging from van der Waals crystals to covalent ones. Phonons ranging from intra-cluster to lattice vibrations play an important role for determining the electronic states, and the situation is very different from the conventional materials consisting of atoms. Itinerating conduction electron/hole carries, spreading over the cluster-network, endohedral atomic elements. Phonons, conduction-electrons and magnetic-electrons interplay to produce electronic properties that cannot be obtained in the conventional materials.

One of the most intriguing electronic properties is superconductivity. Electron-phonon interactions are very important in a framework of the conventional Bardeen-Cooper-Schrieffer superconducting theory. Since the C_{60} has intracluster high frequency phonons and the high density of states at the Fermi level, high superconducting transition temperature T_c will be achieved. Another important issue is electron spin ordering to give rise to ferro or antiferro magnetism. Novel series of magnetic nano materials will be constructed.

The most important researches in this century shall be nano materials science and technology. The talk will be focused on novel materials on a basis of nano clusters and some experimental evidences towards this future dream.