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Magnetism in Ge Nanostructures

Yung Liou*[1], Yen Lin Shen[2], Yun Chung Chi[2] and Huei-Ying Ho[1]
[1]Institute of Physics, Academia Sinica, Taipei, Taiwan, 10529, ROC
[2]Department of Materials Engineering, National Taiwan Ocean University, Keelung, Taiwan, ROC
*Corresponding author: yung@phys.sinica.edu.tw, Phone: +886 2 2789 6723, Fax: +886 2 2783 4187

Nanostructures with unexpected properties absent in their bulk counterparts have fascinated people for many years. However recent reports of room-temperature magnetism in nanoparticles have attracted even more attentions. Quantum confinement, surface effect or structural defects all have been used to interpret the magnetism induced by unpaired spins in nanoparticles. Semiconductor quantum dots with unique electronic and optical properties are important in information and communication technologies however the magnetism is missing. Nanosphere lithography, in which various sizes of polystyrene nanospheres are used as a deposition mask to fabricate nanostructures, is an alternative nano-fabrication technique. Monolayer nanospheres as a topographical pattern can also be used to fabricate nanostructures. The curvature of nanospheres may induce lateral film-thickness variations that generated different nanostructures simultaneously from the same deposited materials. Here, we demonstrate that ferromagnetism was observed in Ge nanostructures deposited on monolayer nanospheres. Ge layers with different thickness (3-20 nm) were deposited on nanospheres with various sizes (from 20 nm to 500 nm) by thermal evaporation. The size of Ge nanostructures was influenced by both the thickness of Ge layers and the size of underlying nanospheres. The magnetism in Ge nanostructures increased dramatically as the size of nanospheres or the thickness of Ge layers decreased. A maximum magnetism was observed in Ge nanostructures when a 5 nm thick Ge layer deposited on nanospheres with a diameter of 20 nm. The magnetism in Ge nanostructures was attributed to unpaired electrons occupying split energy levels due to the quantum confinement effect and magnetic coupling among the unpaired spins.

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The Disorder Effect on Magnetic Properties of Ce_3Al_{11} Small Particles

C. R. Wang*, Y. J. Zung
Department of Physics, Tunghai University, Taichung, Taiwan, R.O.C
*Corresponding author: wangcr@thu.edu.tw

The bulk Ce_3Al_{11} undergoes a ferromagnetic transition at $T_C \sim 6.2$ K , follow by an antiferromagnetic ordering at $T_N \sim 3.2$ K . In previous researches , the reduced Curie constants and the depressed magnetic order appear in the nanoscale specimens. In order to investigate the influence of disorder on small particles, the particles was fabricated by ball-milling(BM) method. The structure disorder were leaded by milling process. X-ray diffraction (XRD), high resolution transmission electron microscopy (HR-TEM) and scanning electron microscopy (SEM) , were used to analyze the structure and the sizes of these particles. The sizes of ball-milling (BM) samples were about 338 ± 263 nm. We found that the antiferromagnetism of the particles were suppressed, which is similar to the nanoparticles fabricated by pulsed-laser-deposition method. A typical behavior of superparamagnetism exhibited on the χ-T curve below 6K , imply that the samples remain on ferromagnetic state between 2K and 6K. The Curie-constant was about 78% of the bulk. By the calorimetric measurements, we find that the broaden ferromagnetic and the antiferromagnetic transitions still exist in BM-speciment with smaller entropy calculated from specific heat data . These results imply the possible disorder effect on interaction between Ce ions resulting in the depress of magnetic moment and ordering.