Solvothermal hot injection metal nanoparticle synthesis

Vít Vykoukal

Ústav chemie, Př. F. MU

Nanomaterials and especially their preparation by chemical approach is a very attractive field of materials research. The synthesis of nanoalloys is one integral part of nanoscience and development of efficient methods is a challenging task due to their chemical, phase, and morphological variability.

Nanoparticles of metal alloys exhibit many interesting properties, such as depression of melting point, plasmon resonance, catalytic activity and phase separation. Nanoalloys can be prepared by many routes, but the solvothermal synthesis, specifically in oleylamine is highly advantageous. Hot injection technique should ensure homogeneous conditions for nanoparticles nucleation and growth.

AgNi nanoparticles were prepared by injection of an oleylamine solution of $AgNO_3$ and $Ni(acac)_2$ (different molar ratios) and AgCu were prepared by injection of $[Ag(DDA)_2NO_3]$ and $[Cu(PPh_3)_2BeA]$ or $[Cu(PPh_3)_3Hphtal]$ (eutectic ratio = 60:40 mol%) to a mixture of oleylamine and octadecene at 230 °C. After 10 minutes, the reaction mixture was cooled down to room temperature in a water bath. Then 20 cm3 of acetone was added to precipitate nanoparticles and the suspension was centrifuged. The precipitate was washed by a mixture of hexane and acetone. This procedure was repeated twice and finally the precipitate was dispersed in hexane and characterized.

Dynamic light scattering (DLS), transmission electron microscopy (TEM), Scanning transmission electron microscopy with energy dispersed spectroscopy (STEM-EDS), elemental analyses (ICP OES), and small-angle x-ray scattering (SAXS) analyses were performed for determination of chemical composition, average size, size distribution, and shape of the prepared nanoparticles. Plasmon resonances were also observed. Phase separation was observed by high temperature x-ray diffraction (HT-XRD) technique and was confirmed by scanning electron microscope (SEM) and by measuring of magnetic properties during heating.