Formation of Nanoparticles of Cobalt Oxides by Laser Ablation in Liquids

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Laser ablation in liquids is concentrating much attention as a new technique to prepare nanoparticles. An advantage of this technique is simplicity of the procedure. In principle, nanoparticles of various species of materials can be prepared by using one procedure. However, most of previous studies have been concerned with only preparation of nanoparticles of noble metals. It is important to extend this technique to preparation of nanoparticles of other materials, especially nanoparticles of compound materials such as metal oxides and semiconductors which are difficult to be prepared by using chemical synthesis.

In this study, we have carried out laser ablation of cobalt and cobalt oxides (CoO and Co₃O₄) to prepare their nanoparticles. Nanoparticles of CoO and Co₃O₄ are promising materials for electronic devices and gas sensors. We have carried out laser ablation in water and hexane to investigate influence of solvent on atomic composition of produced nanoparticles.

Powders of source materials (Co, CoO, and Co₃O₄) were suspended in solvents and were stirred while laser ablation. The third harmonic output of a Nd:YAG laser was used as ablation laser light. Typically, laser ablation was carried out at 30 mJ/pulse for 60 min. Produced nanoparticles were analyzed by using a TEM.

Figure 1 shows nanoparticles prepared from Co, CoO, and Co₃O₄ powders in water. From all materials, spherical particles of 50-100 nm in diameter and non-spherical particles of less than 10 nm in diameter were produced. To investigate composition of these nanoparticles, electron diffraction patterns were analyzed. It was found that nanoparticles produced from all materials in water were composed of Co₃O₄. On the other hand, it was found that nanoparticles produced in hexane were composed of Co, indicating that solvent influences composition of products. These findings suggest that nanoparticles were produced via photochemical and photothermal processes of laser ablation involving both materials and solvents.

References