Journal of the Korean Ceramic Society (2020) 57:385–391
https://doi.org/10.1007/s43207-020-00044-x

ORIGINAL ARTICLE

Effect of boron addition on the phase-transition temperature of CoPt-B nanoparticles synthesized by sol–gel autocombustion using sago starch as a chelating agent

Prawit Nuengmatcha[1] · Amnuay Noypha[2] · Witoon Tangwatanakul[3] · Thanida Charoensuk[4] · Paweena Porrawatkul[1] · Saksit Chanthai[5]

Received: 20 February 2020 / Revised: 21 March 2020 / Accepted: 27 March 2020 / Published online: 8 April 2020

Abstract

In this research, we reported the effect of boron addition on the phase-transition temperature of CoPt-B nanoparticles using a sol–gel autocombustion method. Sago starch was used as a chelating agent. From the results, the suitable values of the sago starch concentration, boron concentration, and annealing temperature were determined to be 10% (w/v), 0.20 mol/L, and 500 °C, respectively. All the synthesized samples were characterized by the SEM, TEM, EDS, XRD, and VSM techniques. The XRD patterns of the synthesized CoPt-B nanoparticles demonstrated that the phase-transition temperature of CoPt-B changes from the disordered A1 phase to the ordered $L1_0$ phase at 500 °C. It can be concluded that the addition of boron could reduce about 100 °C of the ordering temperature of CoPt-B. Moreover, the VSM data confirmed that the obtained samples exhibited their ferromagnetism properties, indicating that the synthesized CoPt-B nanoparticles can be applied as ultrahigh-density magnetic recording media.

Keywords CoPt-B nanoparticles · Boron · Sol–gel · Sago starch

1 Introduction

At present, magnetic nanomaterials such as FePt, FePd, and CoPt have been receiving much attention considering their potential applications in various fields, e.g., mechanical actuations, biomedical diagnostics, drug delivery, advance fuel-cell catalysis, and ultrahigh-density magnetic recording media [1–3]. Particularly, the $L1_0$ phase CoPt nanoparticles with face-centered tetragonal (FCT) structure are considered promising as ultrahigh-density magnetic recording media due to not only their high magnetic anisotropy but also their large oxidation and corrosion resistance [4–6]. Although researchers can synthesize different phases such as $L1_0$, $L1_1$, $L1_2$, and face-centered cubic (FCC) under various experimental conditions, the $L1_0$ phase CoPt nanoparticles is challenging material [7–10]. To form the $L1_0$ phase CoPt structure, a higher annealing temperature (600–900 °C) than the traditional method is required [11, 12]. However, the following unexpected factors may arise such as an increase in the grain size, lattice deformation, coalescence, phase-transition lattice deformation, etc.[13, 14], which limit its practical utility.

✉ Prawit Nuengmatcha
pnuengmatcha@gmail.com; Prawit_nue@nstru.ac.th

1 Nanomaterials Chemistry Research Unit, Department of Chemistry, Faculty of Science and Technology, Nakhon Si Thammarat Rajabhat University, Nakhon Si Thammarat 80280, Thailand

2 Department of Physic, Faculty of Education, Nakhon Si Thammarat Rajabhat University, Nakhon Si Thammarat 80280, Thailand

3 Academy for the Study of Science, Technology and Language Learning, Surawiwat School, Suranaree University of Technology, Nakhon Ratchasima 30000, Thailand

4 Molecular Technology Research Unit, School of Science, Walailak University, Nakhon Si Thammarat 80160, Thailand

5 Materials Chemistry Research Center, Department of Chemistry and Center of Excellence for Innovation in Chemistry, Faculty of Science, Khon Kaen University, Khon Kaen 40002, Thailand