Effect of graphene nanoparticles addition on superconductivity of YBa2Cu3O7~δ synthesized via the thermal treatment method

ABSTRACT

The development of high-temperature superconductor (HTS) YBa2Cu3O7~δ (Y123) bulks in industrial applications were established years ago. It is one of the developments that currently attracts great attention especially in transportation, superconductor cables and wires. This study is focused on the preparation of the Y123 bulk superconductors by the thermal treatment method due to the promising ways to develop high-quality Y123 superconductors with its simplicity, low cost, and relatively low reaction temperature used during the process. Y123 were added with graphene nanoparticles (x = (0.0–1.0) wt.%). Samples were then characterized by X-ray diffraction (XRD) analysis, field-emission scanning electron microscopy (FESEM), energy-dispersive X-ray spectroscopy (EDX), and alternating current susceptibility (ACS). It was found that Y123 confirmed that the majority of phases in all the XRD patterns was the orthorhombic crystal structure and the Pmmm space group with secondary phases belonged to Y2Ba1Cu1O5 (Y211). The highest Tc obtained when graphene nanoparticles were added in the Y123 sample was x = 1.0 wt.%, followed by x = 0.5 wt.% with 92.64 and 92.59 K, respectively. From the microstructure analysis, the average grain size significantly decreased to 4.754 μm at x = 0.5 wt.%. The addition of graphene nanoparticles had disturbed the grain growth of Y123, affecting the superconducting properties of the samples. On the other hand, the intergranular critical current density, Jcm, was found to increase with graphene nanoparticle addition and had the highest value at x = 1.0 wt.%, indicating that graphene nanoparticles acted as pinning centers in the Y123 matrix.

Keyword: Y123 superconductor; Thermal treatment method; Graphene nanomaterials