Abstract

Superconductor samples of type (CoFe$_2$O$_4$)$_x$GdBa$_2$Cu$_3$O$_{7-\delta}$, $0.0 \leq x \leq 0.1$ wt.%, were synthesized by the conventional solid-state reaction technique. The prepared samples were investigated using X-ray Diffraction (XRD), Scanning Electron Microscope (SEM), electrical resistivity, AC magnetic susceptibility, and Vickers microhardness. Phase examination by XRD indicated that the orthorhombic structure of Gd-123 is not affected by nanosized ferrite CoFe$_2$O$_4$ addition, whereas the volume fraction of Gd-123 increased with $x$ up to 0.01 wt.%. Morphological investigations by SEM revealed that the porosity among grains decreased as $x$ increased from 0.0 to 0.1 wt.%. The superconducting transition temperature $T_c$ was estimated from electrical resistivity and the AC magnetic susceptibility measurements. A reduction in $T_c$ was observed as $x$ increased from 0.0 to 0.1 wt.%, consisting with the effect of adding magnetic impurities to HTSCs. Room temperature microhardness measurements were carried out at different applied loads (0.5–10 N) for the study of the mechanical performance of the studied samples. The experimental results were analyzed using Meyer's law, Hays–Kendall approach, elastic/plastic deformation model, and proportional specimen resistance model. The results showed that all the samples exhibited normal indentation size effect, and Vickers microhardness values were increased as nanosized CoFe$_2$O$_4$ addition increased. The analysis showed that the proportional specimen resistance model is the best model for computing the load-independent microhardness values of our samples.