Superconducting and Electrical Transport Properties of (Bi\textsubscript{1.4}Pb\textsubscript{0.6})Sr\textsubscript{2}Ca\textsubscript{2}Cu\textsubscript{3}O\textsubscript{10} with Nano-Co\textsubscript{0.5}Ni\textsubscript{0.5}Fe\textsubscript{2}O\textsubscript{4} Addition

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The effects of nano-CoFe\textsubscript{2}O\textsubscript{4} addition on the superconducting and transport properties of (Bi\textsubscript{1.4}Pb\textsubscript{0.6})Sr\textsubscript{2}Ca\textsubscript{2}Cu\textsubscript{3}O\textsubscript{10} high temperature superconductor (Bi-2223) were studied. Bi-2223 superconductor samples were prepared using co-precipitation method. 0.01 to 0.05 wt.% of Co\textsubscript{0.5}Ni\textsubscript{0.5}Fe\textsubscript{2}O\textsubscript{4} magnetic nanoparticles with average size of 20 nm was added to enhance the flux pinning and improve the transport properties of the Bi-2223 superconductor \cite{1-2}. The Co\textsubscript{0.5}Ni\textsubscript{0.5}Fe\textsubscript{2}O\textsubscript{4} particle size is larger than the coherence length, $\xi$ and smaller than the penetration depth, $\lambda$ of Bi-2223 ($\xi = 2.9$ nm, $\lambda = 60 – 1000$ nm for Bi-2223 \cite{3}). The critical temperature ($T_c$), critical current density ($J_c$), phase formation and microstructure of the samples were investigated. As shown in Fig. 1, all samples with addition of nano-Co\textsubscript{0.5}Ni\textsubscript{0.5}Fe\textsubscript{2}O\textsubscript{4} showed higher $J_c$ compared to non-added sample. The sample with 0.01 wt.% addition showed the highest $T_c$ and $J_c$. A higher amount of addition (>0.01 wt.%) leads to degradation of both $T_c$ and $J_c$. This study shows that small addition of Co\textsubscript{0.5}Ni\textsubscript{0.5}Fe\textsubscript{2}O\textsubscript{4} nanoparticles can effectively enhance the transport critical current density in Bi-2223 superconductor.