On the Roles of $Bi_2Sr_2CuO_x$ in $Bi_2Sr_2CaCu_2O_x$/Ag Round Wire Transport on Multiple Length Scales

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Abstract - Despite 25 years of significant improvements in the performance of $Bi_2Sr_2CaCu_2O_x$ (Bi2212)/Ag multifilamentary round wires (RWs), understanding the impact of microstructural defects, on multiple length scales, on the transport behavior remains a significant challenge. In melt-processed multifilamentary RWs the primary impurity is $Bi_2Sr_2CuO_x$ (Bi2201) which forms as mesoscopic grains and nanoscopic intergrowths. Here, the effect of Bi2201 grains on transport are analyzed quantitatively using a statistical approach in which filaments are categorized based on the predominant phases observed by cross-sectional scanning electron microscopy. It is found that critical current density (Jc) is inversely proportional to the percentage of filaments containing large Bi2201 grains. Bi2212 intergrowths are studied with atomic resolution aberration corrected scanning transmission electron microscope (STEM). Insight into the roles of Bi2201 intergrowths is obtained by relating the STEM results to the Bi2212 coherence length (ξ), anisotropic magnetization behavior and magnetic-field dependent electrical transport. Bi2201 intergrowths are shown to play a complex role in Bi2212/Ag wire transport through their impact on c-axis transport and flux pinning depending on the length scale.