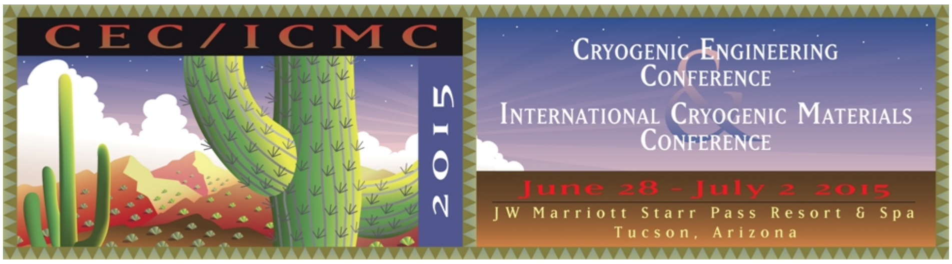

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Correlation of critical current density of bulk MgB2 having high connectivity between SC grains with concentration and distribution of higher magnesium borides and oxygen-enriched inhomogeneities, the role of Ti additions

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MgB2-based bulk materials synthesized under 30 MPa –2 GPa pressure demonstrated an enhanced connectivity, AF ~50–98% compared to other reports (below 50%) and a shielding fraction of 75–100 %. The materials demonstrate high critical current densities, jc, but no strict correlation was found between AF and jc. On the other hand, we found correlations between jc and the distribution of nanostructural inhomogenities like impurity oxygen as oxygen-enriched Mg–B–O nanolayers or nanoinclusions and its solution in the MgB2 matrix and with the amount and size of higher magnesium borides MgBx, x≥4 inclusions. With increasing MgB2 manufacturing temperature from 600÷800oC to 1050÷1100oC the Mg–B–O nanolayers transform into separate dispersed Mg–B–O inclusions and the sizes of inclusions of higher magnesium borides are decreased. The tendency is observed in a wide range of synthesis pressure (0.1 MPa–2 GPa). The described structural transformations are accompanied by an increase of jc in low and medium magnetic fields and by transition from the grain boundary to the point pinning. The Ti addition results in a further increase in jc due to: Ti promotes the formation of MgBx inclusions and segregation of oxygen in a MgB2 matrix, thus shifting the formation of Mg–B–O separate nanoinclusions to lower synthesis temperatures and facilitates the formation of a homogeneous MgB2 matrix with lower oxygen content, but with an increased number of Mg–B–O and MgBx pinning centers. Ti-contained inclusions are rather big to be pinning centers by itself. Besides, Ti absorbs impurity hydrogen forming titanium hydrides, thus preventing material from cracking and formation of MgH2, especially at low synthesis temperatures. The results of the jc and AC loss study by transformer method and trapped magnetic field using rings from MgB2 are discussed.

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