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Wed-Af-Po3.21-04 [70]: Mechanical strength evaluation of the internal matrix reinforced Nb3Sn multifilamentary wire using Cu-Sn-In ternary alloy matrix

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The degradations of superconducting properties due to the loading of mechanical stress and strain on the practical Nb3Sn wire are serious problem to apply for the future fusion magnet operated under higher electromagnetic force. Recently, we investigated the internal reinforcement method without reinforcement material using Cu-Sn ternary alloy matrix and found that mechanical strength of bronze processed Nb3Sn wires was improved by the Cu-Sn-Zn ternary alloy matrix. The Cu-Sn-Zn ternary alloy matrix was transformed to the (Cu, Zn) solid solution based on the solid solution strengthening mechanism.
Generally, it is well known that there are many solute elements for the solid solution strengthening of copper binary alloy. For the further mechanical strength improvement, we focused on the Indium (In) as the more effective solute element compared with the Zn element and fabricated bronze processed Nb3Sn multifilamentary wire using various Cu-Sn-In-(Ti) ternary alloy matrices.
In this study, the change of the Vickers hardness before and after Nb3Sn synthesis heat treatment and the transport critical current (Ic) under the uniaxial tensile deformation on the these Nb3Sn multifilamentary wires using Cu-Sn-In-(Ti) ternary alloy matrices were evaluated. We confirmed that Vickers hardness of the matrix after Nb3Sn synthesis heat treatment on the Cu-Sn-In ternary alloy matrix samples was higher compared with the conventional bronze processed sample and was increased with increasing nominal In composition. This would be mainly caused by the (Cu, In) solid solution formation from Cu-Sn-In-(Ti) ternary alloy matrix, as same as the case of the Cu-Sn-Zn ternary alloy matrix. In element would become more attractive solute element of the ternary alloy matrix for the internal matrix reinforcement.
In addition, we also carried out the tensile test under 4.2 K and magnetic field of 15 T on the Nb3Sn multifilamentary wires using various Cu-Sn-In-(Ti) ternary alloy matrices. Transport Ic behavior by the unidirectional tensile deformation on the Nb3Sn multifilamtary wire using various Cu-Sn-In ternary matrices was also reported.

Primary authors: Prof. HISHINUMA, Yoshimitsu (National Institute for Fusion Science); Dr OGURO, Hidetoshi (Tokai Uiversity); Mr TANIGUCHI, Hiroyasu (Osaka Alloying Works Co.,Ltd); Prof. AWAJI, Satoshi (Institute Materials Research, Tohoku University); Dr KIKUCHI, Akihiro (National Institute for Materials Science)

Presenter: Prof. HISHINUMA, Yoshimitsu (National Institute for Fusion Science)

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