Pressure induced enhancement of superconducting state properties and its correlation with crystallinity degradation of Fe-Te-Se single crystals

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We have already shown that the inhomogeneous spatial distribution of ions with nanoscale phase separation enhances the superconductivity in superconducting Fe-Te-Se chalcogenides [1]. The almost ideal single crystal of $FeTe_{0.65}Se_{0.35}$ exhibits a greater width of superconducting transition and a considerably smaller value of the critical current density in comparison with non-uniform sample of the same compound. Resistivity results confirm that the inhomogeneous spatial distribution of ions and presence of small hexagonal-like phase in chalcogenides with nanoscale phase separation seems to enhance the superconductivity in this system [2]. Here, detailed investigations of Ni substituted $Fe_{0.994}Ni_{0.007}Te_{0.66}Se_{0.34}$ and unsubstituted $Fe_{0.99}Te_{0.66}Se_{0.34}$ crystals performed at ambient and under hydrostatic pressure are presented. Under ambient pressure the weakening of superconducting state properties was observed in $Fe_{0.994}Ni_{0.007}Te_{0.66}Se_{0.34}$ crystal, with disorder introduced by Ni substitution, as compared with those in $Fe_{0.99}Te_{0.66}Se_{0.34}$. For $Fe_{0.994}Ni_{0.007}Te_{0.66}Se_{0.34}$, the x-ray diffraction studies have revealed a degradation of crystal quality under applied elevated pressure. Superconducting state properties of single phase $Fe_{0.99}Te_{0.66}Se_{0.34}$ crystal, such as the upper and lower critical fields, were found to be poorer, at both ambient and hydrostatic pressure, than those observed for $FeTe_{0.5}Se_{0.5}$ crystals exhibiting pronounced nanoscale phase separation. Comprehensive studies of impact of pressure on crystal structure and on superconducting state properties confirm that enhancement of superconductivity under pressure correlates with appearance of mosaicity.

References:

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