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Crystal growth and superconductivity of alkali metal intercalated iron-chalcogenides

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Over last few years considerable attention has been paid to superconducting iron-based oxypnictides (LnFeAsO, Ln: rare earth), pnictides $AEFe_2As_2$ (AE: alkali earth) and chalcogenides (FeCh, Ch: Se,Te) mainly focusing on the interplay between superconductivity and magnetism in these systems.[1,2] Iron chalcogenides are quite exceptional among superconductors because here it is possible to realize the superconductivity having in the structure only "superconducting" layers. This was discovered for the first time by Hsu *et al* in $FeSe_{1-x}$ ($T_c = 8K$).[2] Iron selenides have a Fe square lattice with iron cations tetrahedrally coordinated by Se similarly to the structure of FeAs layers in pnictides. Critical temperature in such system is very sensitive to a change in the strain and can be increased to 37K by applying hydrostatic pressure.[3] Specific behavior of FeCh can be interpreted on the basis of empirical rule proposed by Mizuguchi *et al*, which correlates the critical temperature with the so known "anion height" i.e. the distance between Fe and pnictogen/chalcogen layers.[4] Application of external pressure, either hydrostatic or substitutional, to FeSe crystal results in reduction of the anion height and increases T_c. The extended studies on different dopings in iron selenide system showed that tuning the anion height in FeSe layers by chemical substitution is a very promising way to obtain materials with higher T_c.[5,6] Recently it was found that iron selenide can be doped with monovalent cations (K, Rb, Cs, Tl) which induces the change of local environment of FeSe tetrahedron and injects the extra carriers to the system resulting in strong T_c enhancement ($\sim$ 30K).[7-10] Structure analysis indicates that, similar to pressure effects, the intercalation of parent FeSe with monovalent cations decreases the Se height.[8] Our aim was to grow single crystals of K, Rb, Cs intercalated iron selenides and investigate the influence of iron and alkali metal content on crystal structure and superconducting properties.

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