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Neutron Scattering Study on the New 245 Iron Selenide Superconductors[1]

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We determine using neutron and x-ray diffraction method the sample composition, crystalline structure and magnetic order of the recently discovered $A_2Fe_4Se_5$ superconductors (A=K, Rb, Cs, Tl/K or Tl/Rb). Contrary to initial belief that these materials are heavily electron-doped variety of the BaFe2As2 family of Fe-based superconductors, they are almost charge balanced with the Fe valence close to 2+ as in the 11 iron selenide superconductors, and crystalize in an Fe vacancy-ordered lattice structure [1,2]. Coexisting with superconductivity is a novel block antiferromagnetic order which conforms to the tetragonal crystalline symmetry and possesses a very large ordered magnetic moment $3.3\mu_B$ per Fe and a very high ordering temperature above 500 K [1]. Such Fe vacancy ordered crystal structure and coexisting antiferromagnetism and superconductivity occur in all 5 types of new iron selenide superconductors discovered so far. With Fe vacancy number departs from the chemical formulas $A_2Fe_4Se_5$, an imperfect version of the Fe vacancy order results at base temperature while phase separation into two vacancy-ordered phases exists at the intermediate temperature range [4]. The Fe site disorder renders the materials insulating and destroys the superconductivity as spin-glass disorder does in previous 11 iron selenide superconductors [5].

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