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Composition - Temperature Phase Diagram of Iron-Based Superconductors Tuned by Disorder

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Two phase transition lines forming composition – temperature phase diagram of iron-based superconductors (IBS): antiferromagnetic Spin Density Wave (SDW) and superconducting (SC) can be tuned in large extend by controlled disorder. I will present measurements of magnetization and electronic transport of $Ba(FeAs_{1-x}P_x)_2$ crystals, modified by point disorder induced by low temperature electron irradiation or by correlated disorder produced by swift heavy ions. Strong depression of SDW transition by both types of disorders is consistent with itinerant magnetism of IBS. SDW transition of Lifshitz type preserves its character even in strongly disordered material. Depression of superconducting transition temperature T_c by point disorder is proportional to the dose and reaches values below 1/3 of initial T_c without saturation. In contrast, increase of normal state resistivity induced by columnar defects has almost no effect on T_c. It is consistent with absence of pair-braking effect of intraband scattering channel prevailing for this type of disorder. The region of particular interest is that of slightly underdoped materials where magnetic and superconducting orders co-exist. The sequence of transitions (in the function of temperature on cooling) from normal, paramagnetic to antiferromagnetic and finally to superconducting state can be modified by disorder to direct transition from paramagnetic metal to superconductor. Extension of the SDW transition line can be traced inside of the superconducting dome by abrupt change of the critical current. This transition line follows the evolution with irradiation dose of SDW phase of the ground state and disappears at sufficiently high disorder. This confirms disorder induced downward shift in composition of putative Quantum Critical Point [1].

[1] Yuta Mizukami, *et al.* Journal of the Physical Society of Japan, 86, 083706 (2017)

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