High temperature superconductors

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Resistance-free electrical currents, ideal diamagnetism and quantum coherence of Cooper pairs open extremely wide range of application of superconductors. Despite the fast developing cryocooler technology the necessity of low temperatures represent the main obstacle for much larger scale applications of theses revolutionary materials. The ultimate goal of the superconducting research is a room temperature superconductor. The cuprates [1] with their presumably exotic coupling mechanism were almost two decades the only available high temperature superconducting materials. Although they are still the champions their monocracy has already been attacked from two sides. In 2001 the magnesium diboride returned the classical intermetallic systems back to the game [2]. Recently, the iron pnictides opened a whole new playground [3] for very high field applications, for example.

Europe and Japan proved to be leaders in superconducting research and concentrated common effort of many small scale laboratories can be very profitable in further development of superconducting materials. In 2009 the European Commission and JST organized EU-Japan Experts' Workshop on Novel Superconducting Materials, where I participated, with a successive common call on superconducting materials and devices' projects. I will give some examples of the research on superconducting materials at extreme conditions in our laboratory (ultralow temperatures, high magnetic fields and nanoscale studies) allowing for progress in technologically prospective superconducting materials [4-6]. I will overview our already existing collaborations with Japanese laboratories incl. NIMS on the subject.

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