Designing heterostructures with higher temperature superconductivity

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We propose to increase the superconducting transition temperature Tc of strongly correlated materials by designing heterostructures which exhibit a high pairing energy as a result of magnetic fluctuations [1]. More precisely, applying the Renormalized Mean-Field Theory (RMFT)[2] of the doped Mott insulator, we envisage a bilayer Hubbard system where both layers exhibit prominent intralayer (intraband) d-wave superconducting correlations. Introducing a finite asymmetry between the hole densities of the two layers such that one layer becomes slightly more underdoped and the other more overdoped, we evidence a visible enhancement of Tc compared to the optimally doped isolated layer. Using the bonding and antibonding band basis, we show that the mechanism behind this enhancement of Tc is the interband pairing correlation mediated by the hole asymmetry which strives to decrease the paramagnetic nodal contribution to the superfluid stiffness. For two identical layers, Tc remains comparable to that of the isolated layer until moderate values of the interlayer single-particle tunneling term. These heterostructures shed new light on fundamental questions related to superconductivity. [1]. K. Le Hur, C.H. Chung, I. Paul, arXiv:1010.5140. [2]. F. C. Zhang, C. Gros, T. M. Rice and H. Shiba, Supercond. Sci. Technol. 1, 36 (1988).