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Effect of weak disorder on the superconducting transition SUDHANSU S. MANDAL, Dept. of Theoretical Physics, IACS, Kolkata 700032, India, T.V. RAMAKRISHNAN, Dept. of Physics, BHU, Varanasi 221005, India — We investigate the effects of weak static potential disorder on the superconducting transition in a model of zero range electron-electron attraction and Gaussian random potential acting on otherwise free electrons. We integrate out the electron degrees of freedom to obtain a Ginzburg Landau like functional for the free energy in terms of the space ($\vec{r}$) and time (τ) dependent complex pair amplitude $\Delta(\vec{r},\tau)\exp[i\phi(\vec{r},\tau)]$. We show that the uniform term of order Δ^2 in this functional goes to zero at a temperature $T_c^{\rm BCS}(1-\alpha(k_F\ell)^{-2})$ for $k_F\ell \gg 1$, where $k_F\ell$ is the dimensionless electron mean free path in terms of the Fermi wavevector k_F. The $(k_F\ell)^{-2}$ term arises from a novel disorder induced dynamic pairbreaking process; its origin and the value of the coefficient $\alpha(\sim 1)$ will be discussed. We also show that the superconductivity causing nonzero stiffness condition of the phase gradient $\partial\phi$ has a contribution of order $(k_F\ell)^{-2}$ which reduces it. Our results raise the possibility that with such increasing disorder, as the superconducting coherence length decreases, the phase stiffness decreases with respect to the BCS value. This implies the existence of temperature region with "pre-existing" Cooper pairs but no phase coherence, and a pseudogap. Our results are compared with old and new data on disordered superconductors.

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