Perturbation of the $^{57}$Fe quadrupole interaction at superconducting transition in $Ba_{0.6}K_{0.4}Fe_2As_2$

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Optimally doped ‘122’ compound $Ba_{0.6}K_{0.4}Fe_2As_2$ has been studied by $^{57}$Fe Mössbauer spectroscopy in the temperature range 4.2 – 300K with the particular attention paid to the superconducting transition region around $37K$. Spectra do not contain magnetic components. Hence, the spin density wave (SDW) is completely destroyed by doping in contrast to the parent compound $BaFe_2As_2$ [1]. Spectra are composed of two symmetrical quadrupole doublets. Doublet with narrow lines and smaller splitting contributes about 95% to the absorption cross-section and originates from the iron in the sites unperturbed by dopant. The second doublet is characterized by rather broad lines and has larger splitting. It is due to iron perturbed by dopant. The quadrupole interactions drop at the transition to the superconducting state on both iron sites and recover upon further cooling. This effect could be explained by development of the Cooper pairs, and subsequent raise of the carrier density on the Fermi surface leading to the effective shielding of the electric field gradient (EFG). Widening of the superconducting gap with falling temperature separates bosonic carriers from the remainder of the system and causes recovery of the EFG.

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