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Phase separation and superconductivity in $K_{1-x}Fe_{2-y}Se_2$ single crystals under different thermal treatments HAI-HU WEN, XIAXIN DING, JIAN TAO, HUAN YANG, Physics Department, Nanjing University — Single crystals with the starting composition of $K_{0.8}Fe_2Se_2$ have been thermally treated in three different ways: slow furnace cooling (SFC) from 1020 °C, retreated for 2 hours at 250 °C (S250) and 350 °C (S350:) and followed by quenching. The DC magnetization measurements on them exhibit very different behavior: the SFC samples show a tiny diamagnetic signal, while the sample S350 shows a quite large Meissner shielding volume with the S250 in the middle. The resistive measurements on the sample S350 show zero resistance below 31 K with a sharp transition; while those from the sample SFC or S250 show much larger residual resistance together with a much wider transition. By using the SEM, we have successfully identified that, in SFC, the superconducting areas have relatively larger sizes (about one micrometer) and are widely separated; the superconducting area change into many thin but well connected networks in the sample S350, which construct a 3D spider-web. This explains both the magnetic shielding and the resistive transitions in the three samples. In addition, the superconducting area has a composition of about $K_{0.64}Fe_{1.8}Se_2$. We suggest that the thermodynamically stable phase for the superconducting state has probably one vacancy in every 10 Fe-sites.

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