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Understanding the temperature sensitivity and current sensitivity in two-dimensional transition-edge sensor film

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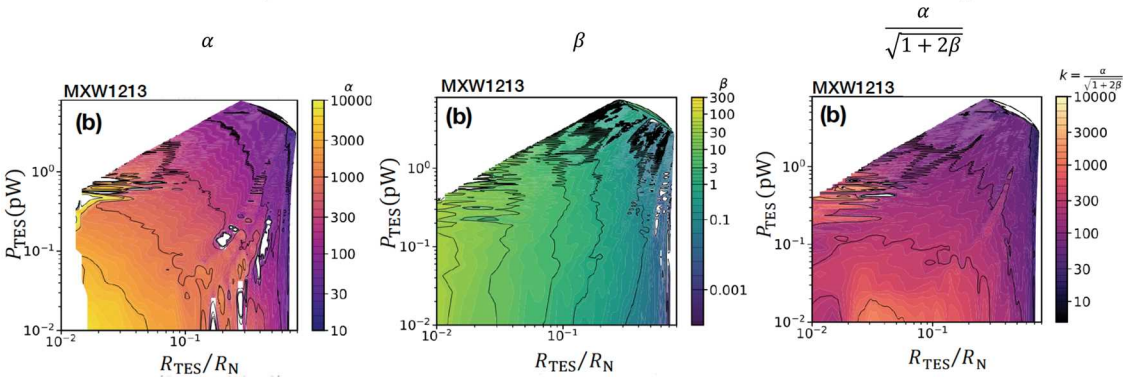
Transition-edge sensor fabricated by normal-superconducting bilayer is widely applied to X-ray spectrometers and infrared to sub-mm image sensors with the aim of potentially unprecedented high energy resolution and sensitivities. As a key component of the X-ray microcalorimeter, the transition-edge sensor has two main parameters that affect the energy resolution, temperature sensitivity and current sensitivity. Tremendous efforts have been made to fabricate transition-edge sensor with high temperature sensitivity and low current sensitivity in order to enhance the energy resolution of the detectors. However, since the resistance of the transition-edge sensor is a complex function of temperature, current and magnetic field, we were lack of systematic knowledge of the resistive surface in its superconducting transition, which has prevented us achieving an optimized operational point of the detector. We thus conducted an experiment to map the resistance, temperature sensitivity and current sensitivity of the transition-edge sensor in its complete superconducting transition, in order to understand if/how the temperature sensitivity and current sensitivity are correlated with each other and where to identify the global optimized bias point to achieve the best energy resolution. As a result, the experimental evidence suggests that the current sensitivity depends only on the resistance of the transition-edge sensor, which supports the prediction of the two-fluid model. With the concept of the phase-slip center as a resistive mechanism, we demonstrate that the figure of merit of the energy resolution as well as the current sensitivity are both correlated with the quasiparticle diffusion length.



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