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Anomalous gap edge dissipation in disordered superconductors at the brink of localization BING CHENG, LIANG WU, NICHOLAS LAURITA, Johns Hopkins Univ, HARKIRAT SINGH, PRATAP RAYCHAUDHURI, Tata Institute of Fundamental Research, NORMAN ARMITAGE, Johns Hopkins Univ — In highly disordered conventional superconductors, it is frequently found that the optical conductivity presents an anomalous additional conductivity below the superconducting gap 2Δ even as T approaches zero. According to Bardeen-Cooper-Schrieffer theory and Matthis-Bardeen (MB) formula, no dissipation state should exist below 2Δ at T=0 K. To resolve this problem, we studied a number of NbN superconducting films by time-domain terahertz spectroscopy. We found an extra conductivity beyond the predictions of MB theory begin to show up even at medium disorder level. With increasing disorder level, more and more optical spectral weights are moved to in-gap region ($\omega < 2\Delta$). By using a self-consistent Abrikosov-Gorkov model, we found, disorder acts as a pairing breaking factor, which blurs the region around the gap edge and introduces dissipative states into the original gap region ($\omega < 2\Delta$) in the optical conductivity. Our results show that the collective modes of superconductivity are not necessary to explain the extra dissipative states in disordered superconductors.

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