Nonthermal Photoresponse in an Organic Superconductor Investigated by Time-Resolved Measurement of Electrical Conductivity

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Time-resolved (TR) spectroscopy is a powerful method for probing photoinduced changes in structure and for the understanding of the relaxation of nonequilibrium states in condensed matters. For superconductors, TR spectroscopy enables us to investigate relaxation dynamics such as quasiparticle recombination and electron–phonon scattering. On contrary to a number of TR experiments on conventional superconductors and cupper oxide superconductors, organic superconductors have been hardly investigated yet. We have so far reported TR measurements of the photoresponse in the electrical conductivity of an organic conductor α-(BEDT-TTF)$_2$I$_3$ [1-5], which shows a metal–insulator phase transition at 135 K. In this paper, we report TR measurements of the photoresponse in the electrical conductivity of an organic superconductor κ-(BEDT-TTF)$_2$Cu[N(CN)$_2$]Br (κ-Br).

The electrical conductivity of κ-Br crystals was measured with a four-probe method. In synchronization with the irradiation of a nanosecond laser pulse (532 nm), the sample was biased with a pulsed current through two of four contacts on the sample. The other two contacts were connected to an oscilloscope to detect the transient change in the voltage difference between them. The observed signal showed that an increase of the resistance was induced by the photoirradiation, and the resistance showed a decay to the original value. A marked temperature dependence of the decay profile of the transient resistance change was observed at temperatures across the T_c. The temperature dependence of the photoresponse intensity showed a maximum at just below the T_c. If the observed photoresponse arose from a thermal effect, the derivative of the temperature dependence of the resistance should be proportional to the photoresponse intensity. However, there is a difference in the two results, suggesting a contribution of nonthermal effect to the photoresponse.

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