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High Power Pulsed Terahertz Light Generation from Superconducting Antenna Arrays

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Motivation

2.5

3.5

4

A terahertz pulse is emitted as a result of the changing current in a superconducting ring due to an incident ultrafast laser pulse. As before, an ultrafast laser pulse is incident on a superconducting ring in a superconducting state with a current \( I_c \). The incident laser pulse breaks the Cooper pairs, restoring resistivity in the ring for approximately 20 picoseconds. The changing current decreases in magnitude in response to the resistance, decelerating the flowing electrons temporarily and causing the emission of the wavefronts. The Cooper pairs then recombine, and superconductivity resumes.

Cooper Pairs Break and Recombine

An ultrafast laser pulse is incident on a superconducting ring in a superconducting state with a current \( I_c \). The incident laser pulse breaks the Cooper pairs, restoring resistivity in the ring for approximately 20 picoseconds. The changing current decreases in magnitude in response to the resistance, decelerating the flowing electrons temporarily and causing the emission of the wavefronts. The Cooper pairs then recombine, and superconductivity resumes.

Cooper Pairs Break and Recombine

Key properties associated with terahertz radiation:

- Non-ionizing
- Transparent to plastics
- Reflective to metals
- Non-destructive
- Spectroscopic fingerprint

Terahertz imaging, operating either in transmission or reflection modes, can be used to see inside containers or to inspect materials for interior damage.

Experimental Setup

Primary experimental equipment:

- Ultrafast laser (15 femtoseconds)
- Superconducting yttrium barium copper oxide ring (BERST antenna)
- Electro-optic sampling detection (ZnTe or GaP)

Detection Scheme: Electro-optic Sampling

Theory

Electro-optic sampling exploits birefringence of the first order, Rockland's effect. The index of refraction is a function of an applied electric field. An incident THz pulse can change the indices of refraction, which can be detected as a change in the polarization of the pulse.

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References