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Development of Lumped Element Kinetic Inductance Detector Arrays for Terahertz Imaging and Spectroscopy

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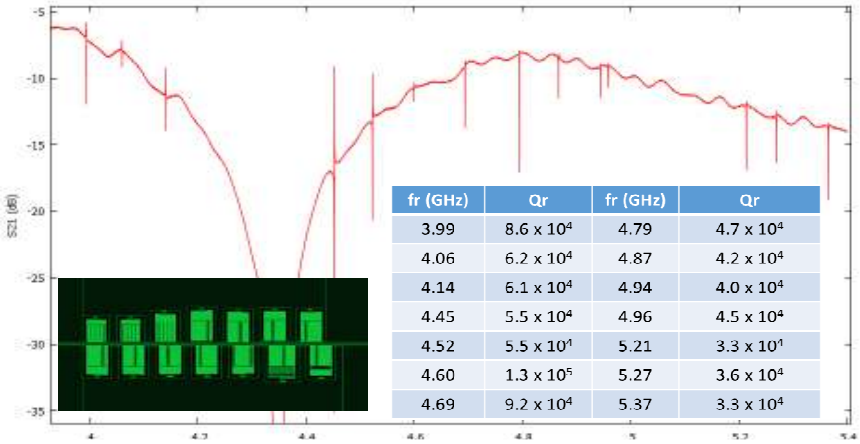
Recent advances of terahertz (THz) technology is making breakthroughs in the various areas including physics, chemistry, homeland security, biology, medicine and material science. We are interested on homeland security applications of THz technology and infrastructure diagnosis. Many commonly used solid-state explosives such as RDX, HMX, PETN and DNT have spectral fingerprints in the range of 0.5-3 THz[1]. THz waves can penetrate through many common dielectric materials such as paper, textile, plastic, leather, wood and ceramic. In addition to that, THz waves have low photon energies (million times weaker than the energy of X-ray photons) and will not cause harmful effects to biological tissues. Therefore, THz technology is a safe method for both the operators and the targets. Due to these advantages THz technology is a competitive method for infrastructure diagnosis and inspecting hidden explosives.

For these applications we propose a direct absorbed lumped element kinetic inductance detector (LEKID) array as a possible detector array. Due to the combination of the absorber and the detector in a single element, the LEKID is an extremely simple detector to fabricate large arrays with a high filling factor, requiring only one deposition and etch step to produce an array of up to 1000 pixels multiplexed onto a single feed-line.

As an initial step, to optimize the detector characteristics, we have designed a 14-pixel LEKID array to absorb 1.5 THz radiation. Fig. 1 shows the measured scattering parameters of the 14-pixel LEKID array fabricated using Al superconducting material at clean room facilities of RIKEN. A picture of the LEKID array is shown in the inset figure. Measured resonance frequencies and their quality factors are stated in the inset table. We are currently working to determine the absorption properties of the LEKID array. In the presentation we are going to present our current status of the development LEKID arrays and their performances.



fr (GHz)	Qr	fr (GHz)	Qr
3.99	8.6×10^4	4.79	4.7×10^4
4.06	6.2×10^4	4.87	4.2×10^4
4.14	6.1×10^4	4.94	4.0×10^4
4.45	5.5×10^4	4.96	4.5×10^4
4.52	5.5×10^4	5.21	3.3×10^4
4.60	1.3×10^5	5.27	3.6×10^4
4.69	9.2×10^4	5.37	3.3×10^4

Fig. 1: Scattering parameters of a 14-pixel LEKID array. Insets shows the fabricated array and their resonance frequencies and quality factors.

1. M.C. Kemp, P. F. Taday, B. E. Cole, J. A. Cluff, A. J. Fitzgerald and W. R. Tribe, "Security applications of terahertz technology", in Terahertz for Military and Security Applications, *Proc. SPIE* **5070**, 44-52 (2003)