Transmission of a large-aperture thin film metal strip array

Daria V. Kharchenko[a,b], Mikhail A.Tarasov[b], Lyudmila V. Filippenko[a], Andrey I. Kleev[c], Genrikh D. Bogomolov[c] , and Leonid S. Kuzmin[b]
[a] V.Kotelnikov Institute of Radio Engineering and Electronisc RAS, Moscow
[b] Chalmers University of Technology, Gothenburg, Sweden
[c] P.Kapitza Institute for Physical Problems, Moscow.

***Abstract*—We have developed a new approach for analyzing the diffraction of a plane wave by a thin film metal strip array. Arrays with period of 40 μm and film width 20 μm, and 5/5 μm were fabricated of Cu, Au, Nb films on Si, quartz, Kapton substrates. Transmission coefficient, polarization and spectra were measured in a quasioptical setup with backward wave oscillators as signal source in frequency range of 180-600 GHz.**

I. Introduction And Background

We have developed a new approach for analyzing the diffraction of a plane wave by a strip grating placed on a grounded dielectric slab [1]. It is shown that the resonance operational regimes are possible even in the case when the period of the grating is much smaller than the wavelength. This structure can be applied to enhance the accuracy of measurements of low loss dielectric films as well as the surface impedance of metal films. The considered grating is actually a specific open resonator that is an analogue of the Fabri–Perot mirror resonator, which is widely applied for millimeter and submillimeter-wavelength measurements. Our computational technique can be easy applied for calculations of structures with superconductors. The resonance phenomena cause a significant field concentration inside the structure. This result can be used for designing highly sensitive terahertz-band detectors. The described structure can also be employed for creating various elements of devices applied for generating terahertz-band electromagnetic radiation. The application of various approximate techniques based on equivalent boundary conditions has been analyzed. Results are compared with previous experimental data [2]. The computations have shown, that our method guarantees the sufficiently accurate results within a wide range of the problem parameters.

II. EXPERIMENTAL RESULTS

.We have fabricated several metal film grids with metal/opening period of 20 μm/20 μm, 5/5 μm. Grids were fabricated of Nb 200, 400, 600 nm thick by lift-off technique, Au of 200 nm on quartz, Kapton and Si substrates. Photo of 20/20 μm grid is presented in Fig. 1. We also fabricated grids by chemical etching of Cu films 1000 nm thick. Transmission was measured in a quasioptical setup with a backward wave oscillator as a source of signal. Polarization characteristic of such Au grid on Si substrate is presented in Fig. 2.

Gratings fabricated of Nb films were used as cryogenic polarizers for measurements of polarization selectivity of 345 GHz cold electron bolometers.

Figure 1. Optical image of 20/20 μm Au polarizer

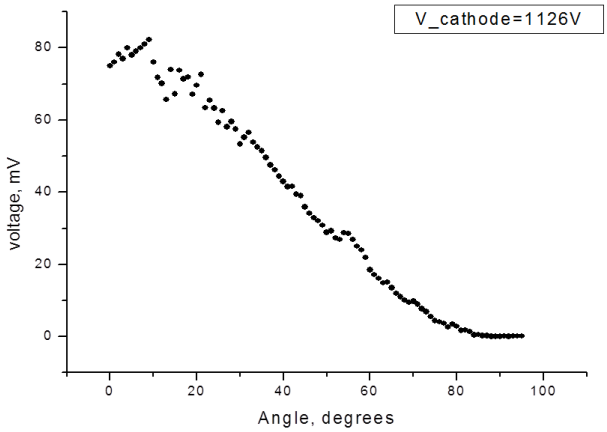

Figure 2. Polarization characteristics of Au array on Si substrate

References

[1] G.D.Bogomolov, A.I.Kleev, " Calculation of Ohmic losses under diffraction on strip grating," *Journal of Communications Technology and Electronics* , vol.54, No 6, pp.645-658 (2009).

[2] Shyh-Shii Pai, Shian-Wen Chang, and Tai-Shen Wang "Reshaped Terahertz waveforms from a large-aperture photoconductive antenna with millimeter scale metal hole and grid combination " *Journal of Applied Physics* 109,053105 (2011)