Cryogenic resonator spectrometer for satellite antennas reflectivity investigation at millimeter and terahertz bands

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Resonator spectrometer developed at IAP RAS is a precision and high sensitive instrument for investigation of reflectivity of metals and coatings in the millimeter (mm) and terahertz bands. An important application of this instrument is investigation of antennas and thermal shields for space telescopes [1-3]. Until recent time the temperature range of sample was limited by liquid nitrogen boiling temperature (78 K). Reflectivity of metal cooled to this temperature differs from theoretical calculation based on normal skin-effect theory. For real metals and coatings it is a problem to calculate the limit of reflective loss for temperatures close to absolute zero ($T \rightarrow 0$ K), because this value depends on several factors in a complex manner: surface roughness, chemical composition, existence of surface structure and preferential directions. However, this limit is important for designing of cooled detector systems and for other applications. The only confident way to determine this value is experimental measurement.

The new laboratory complex, constructed on the base on resonator spectrometer is a great advancement in the aforementioned direction: it allows investigation of dielectrics and metals at temperature from 4 K to 450 K, in a very wide frequency band 60-500 GHz [4]. In this report we present new experimental results obtained by cryogenic resonator spectrometer.

Reflectivity of metalized films for radiation shields of “Millimetron” space observatory with various metal thicknesses were investigated in the MM band from 4 to 300 K. For the first time reflectivity versus temperature dependence of pure metals (Cu, Al) was investigated in 4-300 K range at several frequencies from 150 to 250 GHz. Experimental results are important for cooled antenna systems design for MM and THz waves detection.

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References

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