Electromagnetic waves emitted in VO_2 at metal-dielectric phase transition

A.P. Kamantsev[1], D.S. Kalenov[1], V.V. Koledov[1], D.S. Kuchin[1], M.P. Parkhomenko[1],
S.V. von Gratowski[1], V.G. Shavrov[1], A.A. Komlev[2], A.E. Komlev[2], D.A. Kuzmin[3], I.V. Bychkov[3]

[1]Kotelnikov Institute of Radio-engeneering and Electronics of RAS, Moscow, Russia

[2]Saint-Petersburg Electrotechnical University "LETI", St. Petersburg, Russia

[3]Chelyabinsk State University, Chelyabinsk, Russia

In recent years theoreticians and experimentalists physicists have heightened interest in new effects of electromagnetic waves generation under nonequilibrium processes in condensed media. Phase transitions (PT) of 1st and 2nd orders are progressing at significant deviation from equilibrium state, and in this case the medium is active, i.e. it is capable to emit energy as electromagnetic and acoustic waves. Structural PT goes during a certain time when nuclei of a new phase, phase boundaries, various defects, dislocations and fractures may form in the sample, what lead to the generation of electromagnetic and acoustic pulses. All these defects are accompanied by the formation of inhomogeneous elastic deformations.

Vanadium dioxide, as a prototype of strongly correlated electron materials, is of great interest in condensed matter physics as well for device applications. The electron correlation interplaying with lattice stabilizes a very rich phase diagram of VO_2 that consists of many phases with distinct structures and electronic properties. Transitions between these phases can be driven by temperature, photo-excitation, hydrostatic pressure, uniaxial stress, or electrical gating.

The original experimental setup for the investigation of the sample radiation and the separation of the contributions from radiation caused by the PT, and the contribution from the changes in the reflection coefficient of thermal radiation environment in the frequency-domain of 28-32 GHz, has been developed [1]. The ability to self-radiation of electromagnetic waves from the free surface of the thin film VO_2 sample has been experimentally studied in the wavelength range of 8 mm (Fig. 1).

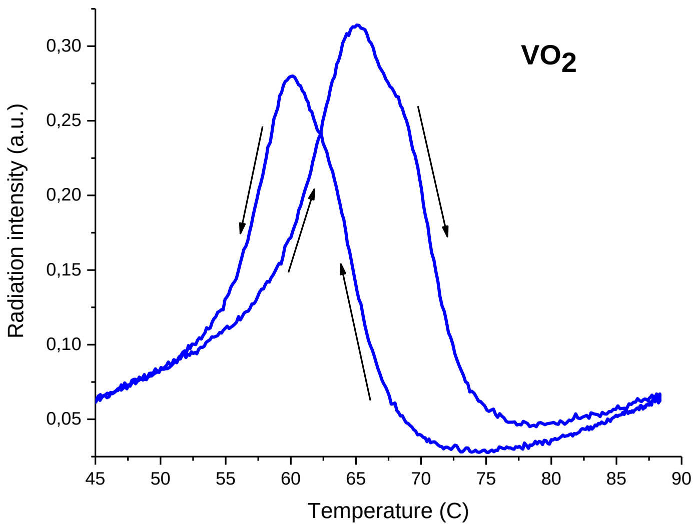

Figure 1. Electromagnetic radiation intensity (in 8 mm) vs temperature in VO_2.

[1] Bychkov I., et.al. Acta Physica Polonica A, 127(2), 588-590 (2015).