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Recently Developed Microwave Devices Based on High-T_c Superconducting Films

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The authors and their colleagues proposed a number of new microwave (MW) devices based on high-T_c (HTS) epitaxial films. Three devices have been developed and made recently in Ka-band. This paper is a survey of the results in this direction.

1. The K-band microstrip (MS) whispering gallery mode resonator (WGMR) was developed on the basis of $DyBa_2Cu_3O_{7-\delta}$ epitaxial film of 600 nm thickness and MgO substrate of 0.5 mm thickness [1]. The resonator was coupled with two HTS MS lines. The results show higher Q-factor of the resonator in comparison with the known MS HTS resonators with lower modes [2].

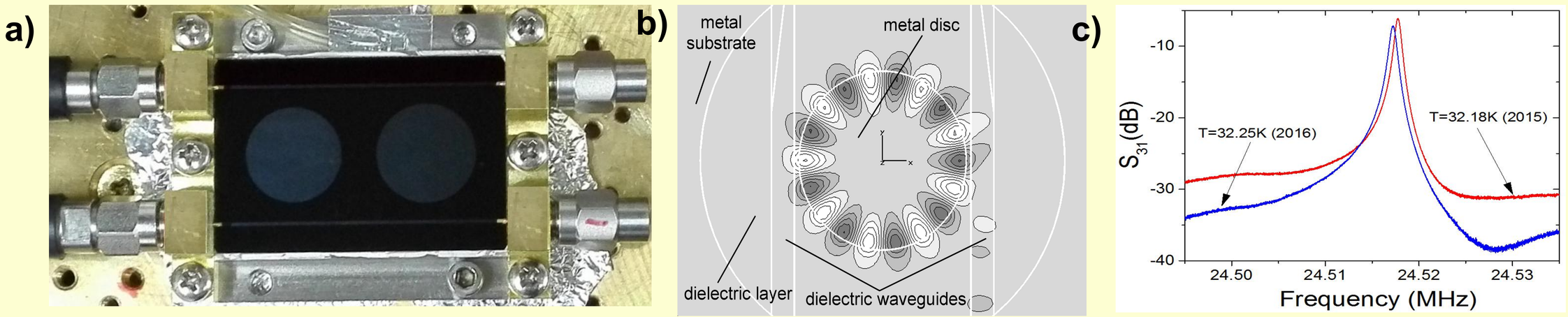

Fig.1. WGM microstrip resonators (two HTS disks) (a), simulated distribution of microwave field (E_z – component) for $H_{9\,1\,\delta}$ mode under HTS disk in a dielectric substrate (b) and resonance line at two temperatures T<Tc (c).

[1]. L. Sun, N. Cherpak, A. Barannik, Y.-S. He, V. Glamazdin, X. Zhang, J. Wang, and V, Zolotaryov, New Type of Microwave High-T_c Superconductor Microstrip Resonator and Its Application Prospects, *IEEE Trans. Appl. Supercond.*, vol. 27, June, 2017 , No 1501304.

2. The idea of **a band-pass filter (BPF) with HTS E-plane insert in the cross waveguide** was implemented using epitaxial HTS $YBa_2Cu3_3O_{7-\delta}$ films sputtered on both sides of MgO single crystal dielectric substrate of 0.5 mm thickness [2].

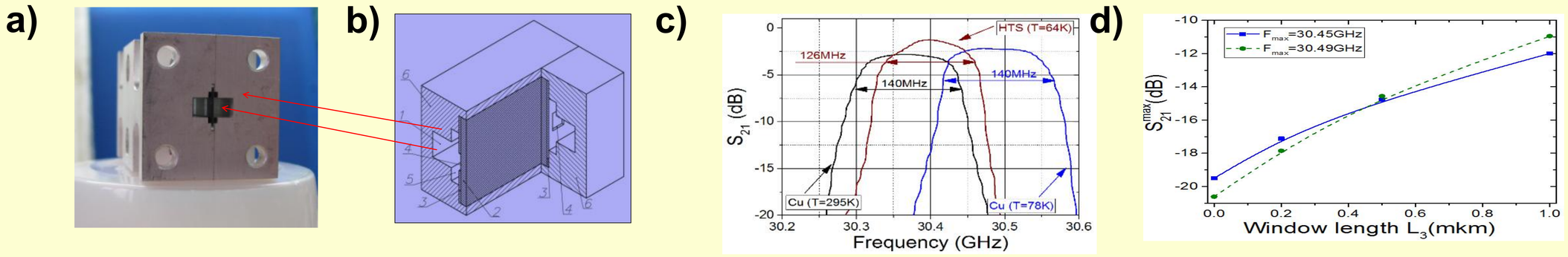

Fig. 2. (a) Photo of BPFs with HTS insert in cross waveguide (CrW), (b) perspective view of BPF based on (CrW) with HTS insert; 1-CrW, 2-single crystal dielectric substrate, 3-HTS film structure, 4-resonator, 6-waveguide body (two parts) of the filter; (b) insertion loss (S_{12}) in enlarged scale of 5-pole BPF with HTS E-plane insert in CrW (at comparing with Cu insert at 78K (blue) and 295 K (black) in rectangular waveguide; (d) changing values of S_{11} at two frequencies depending on variation of the length of central resonant window (see Fig. 4b).

[2]. Y.-S. He, A. Barannik, N. Cherpak, L. Sun, V. Skresanov, Y. Bian, J. Wang, M. Natarov and V. Zolotaryov, Novel Design of Band-Pass Waveguide Filter with HTS E-Plane Insert, vol. 27, 2017 , June, No 1501604.

3. The radially slotted sapphire WGM resonator with cuprate HTS endplates (CEP) was developed for millimeter-wave impedance characterization of the Fe-pnictide and Fe-chalcogenide SC films [3]

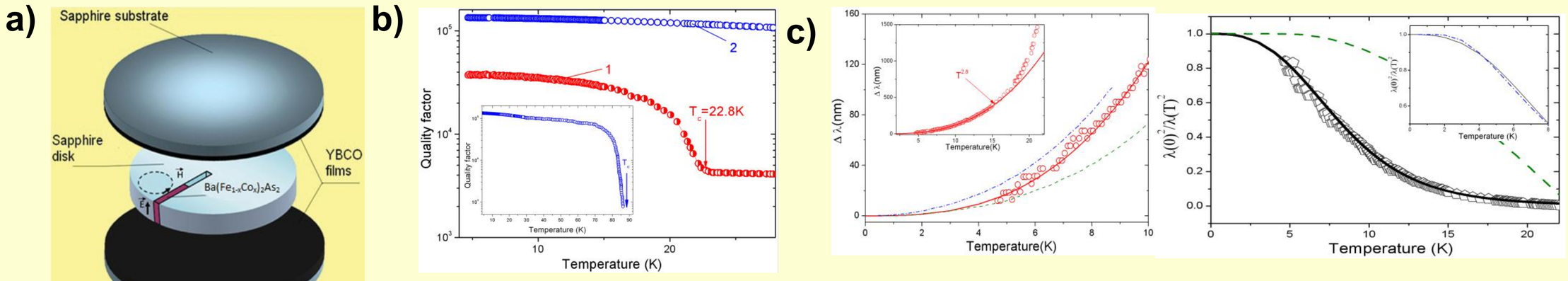

Fig.3. (a) Slotted WGM resonator; Ba(Fe1−*x*Co*x*)2As2 under test in the slot, YBa2Cu3O7 film CEPs are the functional elements; b) Q-factor with (1) and without (2) the sample under test; (c) experiment. phys. data

[3]. A. Barannik, N. T. Cherpak, M. A. Tanatar, S. Vitusevich, V. Skresanov, P. C. Canfield, and R. Prozorov, "Millimeter-wave surface impedance of optimally-doped Ba(Fe1−*x*Co*x*)2As2 single crystals," Phys. Rev. B, vol. 87, 2013, No 014506-(1-7).

Conclusion:

The recently developed HTS-based devices are of certain importance for millimeter-wave physics and technologies.