Reduction of radiation losses of the single-wire waveguide at THz frequencies

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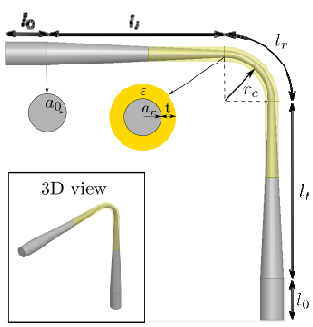
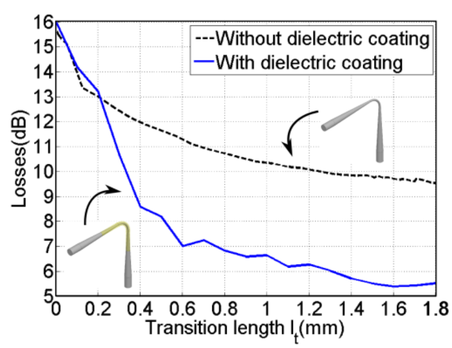
In the last years, many experiments have shown that the single wire waveguide (SWW) is able to guide wide-band THz signals with very low attenuation and negligible dispersion. However, since energy is not transversally bounded, when the wire is bent, strong radiation losses take place. This drawback really limits the practical use of this interesting waveguide. To reduce the radiation on bends one can add a dielectric coating or use a small wire radius, getting better results when both options are combined. Nevertheless, in those cases, the propagation losses of the waveguide become very high and it is no longer a good option for THz waveguiding.

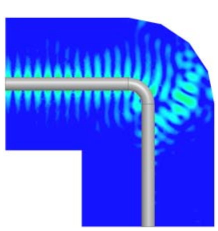
In this work it is proposed the use of transitions between a SWW of large radius and dielectric coated single wire waveguide (DCSWW) of small radius. The proposed structure, Fig. 1a), allows to combine both, a low-loss waveguide to guide the signal along straight paths and a waveguide with reduced radiation losses. Fig. 1b) shows the transmission losses of the structure vs. the transition length. When only the radius is reduced, 9.5dB are obtained for the best case, whereas when also a coating is present, minimum of losses decrease to 5.5dB. There is a large gain compared to the losses of a bend implemented with a SWW of large radius (22dB for a 100μm radius wire). Electric field on the bend is shown in the bottom of Fig. 1 for the three commented options.



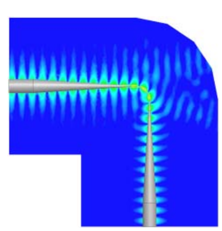
a) Proposed structure squematic.



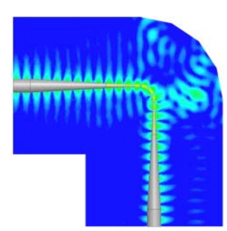
b) Transmission losses vs. the transition length (l_t).



c) Bend without transitions.



d) Transitions without dielectric coating.



e) Transitions with dielectric coating.

Fig 1. Proposed structure and simulation results. Operating frequency is f=1THz, dielectric is TPX (ε_r=2.1,tan δ=0.001) and conductor material is copper ($\sigma=5.8\cdot10^7$ S/m). The total bend length is 3.7mm, the curvature radius is r_c=200μm, the large and the small radius are, respectively, a_0=100μm and a_r=5μm, and the dielectric thickness is t=30μm. The three bottom figures show the electric field magnitude in logarithmic scale with a range of 20dB. The transition length of d) and e) is l_t=1.6mm.