



Sculping the Cutoff and Evanescent Wave in Waveguide

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Waveguide is an important transmission line, especially for high frequency, e.g., millimeter wave or THz, with the merits of high shielding effect and loss radiation loss [1-3]. In the state-of-art technique using waveguide, the propagating mode is usually utilized to design various elements, such as filters, couplers, power dividers, and so on. Here, we move our attentions to the cutoff and evanescent modes, which are avoided in the waveguide design, generating various interesting techniques based on the waveguide theory.

In this talk, we introduce the equivalent TEM wave to analysis the TE₁₀ mode inside waveguide, as illustrated in Fig. 1(a). The equivalent TEM wave is located in the middle plane of the waveguide, with the effective relative permittivity valuing at $\epsilon_{eff} = \epsilon_{act} - (\pi^2 c^2) / (a^2 \omega^2)$, indicating the different modes of the waveguide, as shown in Fig. 1(b). As a new technique shown in Fig. 1(c), the evanescent and propagating modes with $\epsilon_{eff} < 0$ or $\epsilon_{eff} > 0$ are adopted to build waveguide inductors and capacitors, which can be easily integrated with regular waveguides, coined the terminology of waveguide lumped circuits [4]. Based on the cutoff mode with $\epsilon_{eff} \approx 0$, a theory of microscopic doping is built with the assistant of epsilon-near-zero materials, tuning the effective permeability with different dopants [5], as indicating in Fig. 1(d).

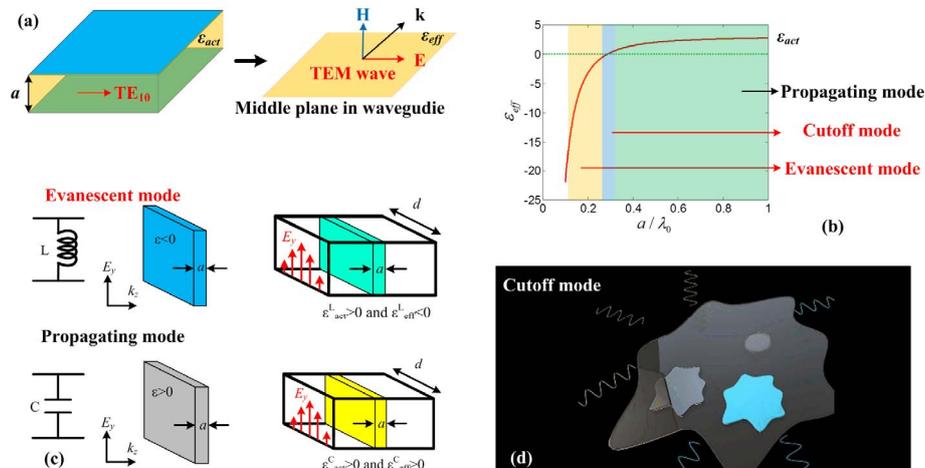


Figure 1. (a) The equivalent uniform plane wave, e.g., TEM mode, of the TE₁₀ mode inside the parallel plate waveguide; (b) The structural dispersion with different height of waveguide in (a), different areas indicate different modes of waveguide. New techniques using cutoff and evanescent modes of waveguide (c) Microscopic doping with cutoff mode; (d) Waveguide lumped circuit elements: the inductor and capacitor are waveguide cavity blocks with evanescent and propagating modes.

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