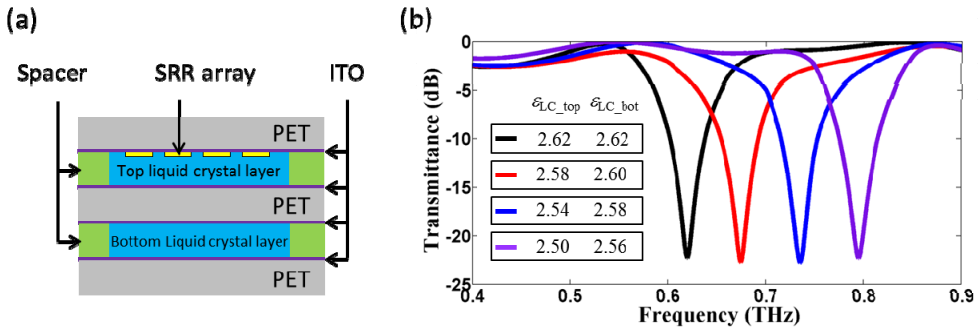

Fig. 5. (a) Schematic drawing of stacked metamaterial device. (b) Simulated transmission spectrums of the device with various permittivities of the liquid crystals. ε_{LC_top} and ε_{LC_bot} are the permittivities of the top and bottom liquid crystal layers, respectively.

5. Conclusions

In conclusion, we report the THz metamaterial device whose resonant transmittance decreases with increasing voltages while its resonant frequency remains at the same value. The decrease in the resonant transmittance results from the liquid crystals/ITO interfaces with large difference in refractive index between these two materials in THz regime. The fixed resonant frequency is attributed to the fact that the electric field of the surface-plasmon-polarition-like mode almost confines in the top PET substrate and therefore the frequency depends mainly on the permittivity of the top PET substrate. By leveraging the switchable resonant transmittance and the fixed resonant frequency, we propose the improved method for those frequency-tunable metamaterial devices so that they can exhibit constant transmittance at different frequencies. Owing to that no aligning layer is needed in the THz metamaterial device, this device has a feature of free polarization for using in band-stop filters.

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