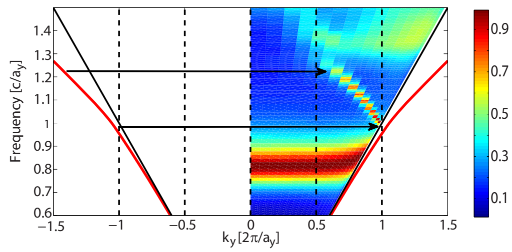

Fig. 5. Absorption spectral map shown in frequency-k_y for the TM mode in the *yz* incident plane. The light line of air is drawn in solid black line. Two red curves depict the dispersion relation of SPPs at an air/alumina/gold interface, with the left curve for the backward SPPs wave and the right curve for forward SPPs wave. The frequency is normalized by c/a_y, where c is the speed of light, and k_y is normalized by $2\pi/a_y$. a_y is 930 nm, the lattice constant along *y*-axis.

We will see that the Q_f of the high-order mode is much larger than that of the fundamental mode. For example, according to the simulation results, for the case of H$\perp$ S_{yz} [Fig. 3(d)] at 60° incident angle, Q_f of the high-order resonance at 880 nm is 34 (the experimental result is even higher, reaching 46), while that of fundamental resonance at 1113 nm is 5.

4. Conclusion

In summary, we experimentally demonstrated a honeycomb-lattice metamaterial absorber, based on a metal-insulator-metal (MIM) structure, operating at the near-infrared regime. We performed the measurement of the absorption of the absorber at different incident angles for both polarizations and incident planes. It is found that besides almost perfect absorption for the fundamental mode (at 1140 nm), the absorber also possesses a narrow-band high-order resonance, which is a Bragg surface plasmon mode. This high-order resonance appears only at oblique incidence, and it has a red-shifting as the incident angle increases. The absorbance is also positively related to the incident angle. Besides, the bandwidth of the high-order mode is much narrower than the fundamental mode. Due to its narrow bandwidth and incident angle sensitive properties, this absorber has the potential to be utilized as high performance optical sensors and thermal emitters.

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