Bound-state-In-the-Continuum effect in complementary metamaterial

Anar Ospanova[1], Ladislau Matekovits[2], Alexey Basharin[1]

1 Center of Photonics Sciences, University of Eastern Finland, Joensuu, Finland
2 Department of Electronics and Telecommunications, Politecnico di Torino, Torino, Italy

Contact: anar.ospanova@uef.fi

Keywords: metamaterial, GHz, microwaves, Bound State in Continuum, transmission, high Q resonance

Bound State In the Continuum – BIC – is an effect anticipated for its high quality and excitation method. BICs are typically characterized by the complete confinement of electromagnetic wave within the continuous spectrum, as well as coexisting with radiating waves that continuously support energy leakage [1, 2]. Another feature is that in highly symmetric structures the effect can manifest itself due to the smallest change in symmetry.

Here we show self-complementary metamaterial comprising two layers resembling chessboard to show BIC effect appearing due to small change on symmetry of the structure. This metamaterial has already shown an ultrabroadband transparency in microwave range [3]. Therefore, we demonstrate that the slightest tilt of the angle of the incident wave results in BIC excitation.

Experimental results demonstrate the appearance of BIC resonance at ~6.5 GHz when impinging wave is tilted by 0.5 degree (Figure 1 a). The effect measured by two-horn antenna method perfectly matches previously simulated results [3]. The measured samples have shown Q-factor ~1000.

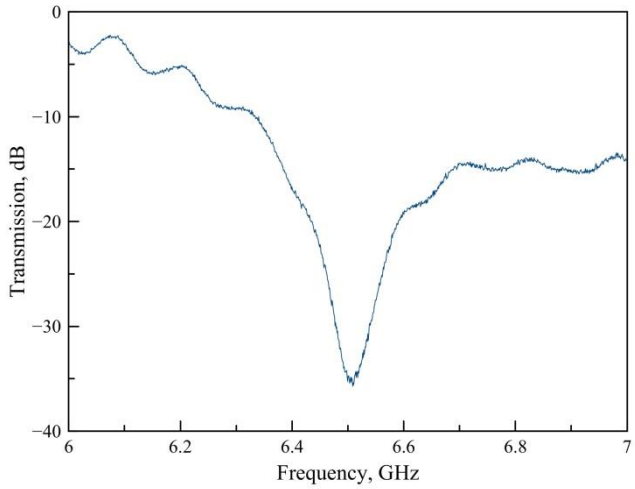

Fig. 1: Experimental results of metamaterial in the range of 6-7 GHz.

BIC engineered structure supports highly localized electromagnetic field that is extremely sensitive to changes in the environment, thus, allows for the confinement and manipulation of light within subwavelength structures. This enables the creation of highly efficient optical devices that are highly demanded in nanophotonics for various applications, including sensing and communication technologies. Nanophotonic sensors based on the BIC effect can be fabricated on a small scale, allowing for integration into compact and portable devices for on-site or real-time monitoring applications.

1. V. I. Kukulin, V. Krasnopolsky, and J. Horacek, “Theory of resonances: Principles and Applications”, (Springer Science & Business Media, 2013)
2. C. W. Hsu, B. Zhen, A. D. Stone, J. D. Joannopoulos, and M. Soljacic, “Bound states in the continuum”, *Nature Reviews Materials* **1**, 1, 2016
3. A. Ospanova, M. Cojocari, P. Lamberti, A. Plyushch, L. Matekovits, Yu. Svirko and P. Kuzhir, A. Basharin, “Broadband transparency of Babinet complementary metamaterials”, *Appl. Phys. Lett.* **122**, 231702, 2023