# Generation and application of the high-Q resonance in all-dielectric metasurfaces

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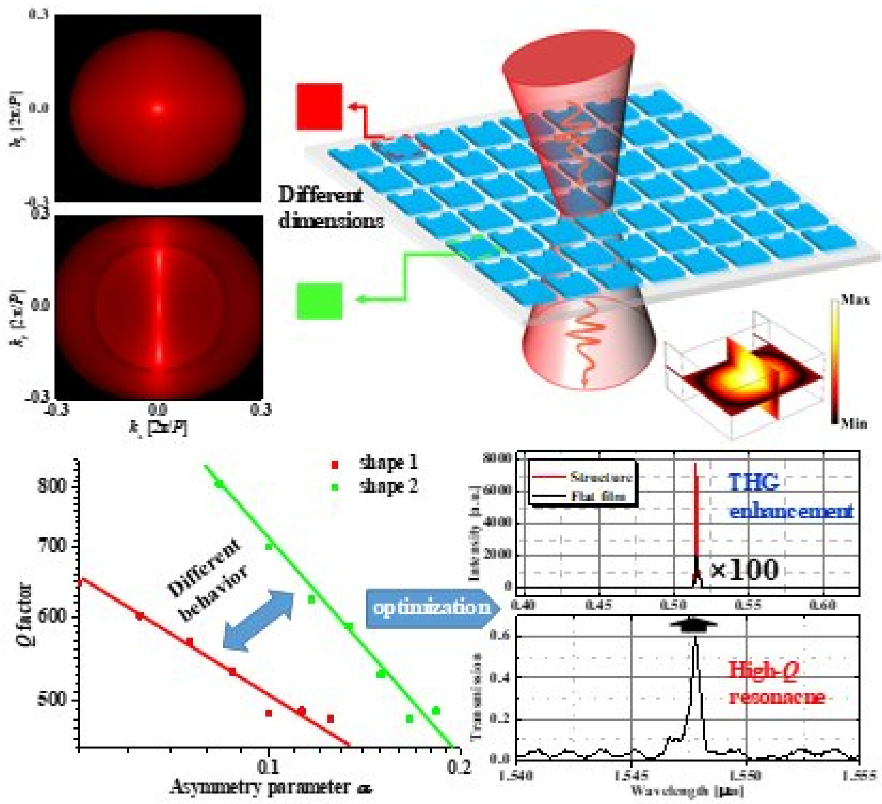


BIC-supporting metasurfaces can achieve the high-Q resonance. The Q factor can be controlled by changing the size of the introduced defect and further this relationship can be adjusted by the proposed design (bottom left). By optimizing the dimensions of the structures, a high-Q resonance can be easily achieved and the THG signal can be enhanced significantly. Credit: Compuscript Ltd

In a new publication from *Opto-Electronic Advances*, researchers led by

Professor Liu Yan from Xidian University, China and Professor Gan Xuetao from Northwestern Polytechnical University, China, consider generation and application of the high-Q resonance in all-dielectric metasurfaces.

Metamaterials are artificial composite electromagnetic structures consisting of subwavelength units, which can realize efficient and flexible control of the electromagnetic waves. Metamaterials are an emerging research area for optoelectronics, physics, chemistry and materials, due to their novel physical properties and potential applications.

With the development in the fabrication of nanostructures, all-dielectric metasurfaces have attracted much research attention because of their high efficiency and low loss. However, metasurfaces based on traditional optical materials (such as silicon) can only support relatively low Q resonances, limiting their applications in lasing action, sensing, and nonlinear optics. A recently emerged concept of bound states in the continuum (BICs) provides a new solution to overcome this problem. The concept of BICs was first introduced in quantum mechanics. It represents a wave phenomenon of modes, which have the energy lying in the delocalized states inside the continuum. The BIC-supporting metasurfaces can achieve controllable high-Q resonance, which can extend their applicability to the devices requiring sharp spectral features.

The authors of this article propose a Si metasurface based on symmetry-broken blocks, which can achieve the high-Q resonance. Nanoparticles made of conventional materials can only support a relatively low quality factor. The concept of BIC provides a new solution to overcome this problem. This concept firstly appears in quantum mechanics, where a true BIC is a mathematical abstraction with infinite Q factor. In this work, symmetry breaking is introduced into the symmetric periodic structure and the ideal BICs turn into the leaky mode with a high Q factor. At the same time, the Q factor of the resonance can be controlled by varying the size of the introduced defects. In addition, by changing the design proposal, the relationship between the Q factor and defect size can also be adjusted. A high-Q resonance can be easily realized in this way and the nonlinear optical effect of the structure can be obviously enhanced at the resonance.

The research reported in this article paves a way to manipulate BICs and realize high-Q dynamic resonances, which constitutes a significant step towards the development of high-Q resonant photonic applications. innovative and advanced optical technologies.

**More information:** Cizhe Fang et al, High-*Q* resonances governed by the quasi-bound states in the continuum in all-dielectric metasurfaces, *Opto-Electronic Advances* (2021). DOI: 10.29026/oea.2021.200030

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