Overcoming the Upper Bound on the Bandwidth-to-Thickness Ratio of Ultrathin Absorbers

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An electromagnetic absorber is a layer that effectively absorbs the incident electromagnetic waves by either converting them into heat or by storing the incoming electromagnetic wave energy for later use. Two main classical types of microwave absorbers include Dallenbach [1] and Salisbury absorbers [2]. A Dallenbach absorber is composed of a metal-backed lossy dielectric. The thickness of the dielectric is about one-quarter of the wavelength inside the dielectric. A Salisbury absorber, on the other hand, is composed of a resistive sheet located one-quarter of a wavelength away from a metallic sheet. Since the introduction of these two absorbers, extensive research has been conducted on applying these concepts to different parts of the frequency spectrum utilizing various natural and artificially engineered materials [3, 4]. Throughout the past several decades, these absorbing layers have emerged as essential building blocks for a multitude of technological applications including energy harvesting, data storage, substance detection, biomedical sensing, and imaging. However, due to their resonant thickness, these absorbers are considerably thick. In recent years, the development of high-impedance surfaces (HIS) and metasurfaces have given new birth to the research in the area of ultrathin absorbers [5]. Although these absorbers can be much thinner than their classical versions, they usually provide narrower bandwidths. From the practical perspective, one of the most important objectives has always been to design the thinnest possible absorbers having the lowest reflectance within the widest bandwidth. However, in a prominent study by Rozanov, it was shown that there is an upper bound on the bandwidth-to-thickness ratio of ultimately thin Dallenbach absorbers [6]. The thinner the absorbers get lower their effective absorption bandwidth will be. Later, a similar upper bound on bandwidth limit was defined for thin absorbers based on metamaterial screens and high-impedance surfaces (i.e., modified Salisbury absorbers) [7]. During this presentation, we will talk about a new concept for designing ultra-thin absorbers based on highly-dispersive matching approach that can go beyond this upper bound defined for conventional absorbers based on high-impedance surfaces. It is shown that the absorbers designed based on the proposed concept can provide several-fold higher absorption bandwidth compared to the same thickness absorbers designed based on conventional approaches.

References

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