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하이퍼볼릭 메타물질: 깊은 서브파장 나노포토닉스를 위한 신개념 플랫폼

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Metamaterials, artificially structured nanomaterials, have enabled unprecedented phenomena such as invisibility cloaking and negative refraction. Especially, hyperbolic metamaterials also known as indefinite metamaterials have unique dispersion relation where the principal components of its permittivity tensors are not all with the same signs and magnitudes. Such extraordinary dispersion relation results in hyperbolic dispersion relations which lead to a number of interesting phenomena, such as super-resolution effect which transfers evanescent waves to propagating waves at its interface with normal materials and, the propagation of electromagnetic waves with very large wavevectors comparing they are evanescent waves and thus decay quickly in natural materials. In this abstract, I will focus discussing our efforts in achieving the unique optical property overcoming diffraction limit to achieve several extraordinary metamaterials and metadevices demonstration. First, I will present super-resolution imaging device called “hyperlens”, which is the first experimental demonstration of near- to far-field imaging at visible light with resolution beyond the diffraction limit in two lateral dimensions. Second, I will show another unique application of metamaterials for miniaturizing optical cavity, a key component to make lasers, into the nanoscale for the first time. It shows the cavity array which successfully captured light in 20nm dimension and show very high figure of merit experimentally. Last, I will discuss the future direction of the hyperbolic metamaterial and outlook for the practical applications. I believe our efforts in sub-wavelength metamaterials having such extraordinary optical properties will lead to further advanced nanophotonics and nanooptics research.

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