Subwavelength resolution using metamaterials with different dispersion relations

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Abstract-The microscope is one of the most important instruments in the nature science, which allows the researchers to “see” small things beyond naked eyes. However, since high spatial frequency information carried by evanescent waves decay exponentially during propagation in free space, the resolution of a conventional microscope is limited due to the diffraction of light which is called Abbe-Rayleigh limit. In the past decades, the concepts of superlens and hyperlens have been proposed to overcome the diffraction limit. Here, we demonstrate a cylindrical hyperlens works for TE polarized waves. The metamaterial forming this hyperlens is based on S-string resonators architecture, which shows two components of the constitutive parameters negative. We also demonstrate a dielectric hyperlens approach to overcome the diffraction limit at ultraviolet frequencies. The hyperlens is designed basing on layered grapheme and layered h-boron nitride, both of which show significant anisotropy and are ideal for hyperlens implementation. Further more, metamaterial without a hyperbolic dispersion relation can be utilized to realize subwavelength imaging as well. We propose a kind of broadband subwavelength imaging using non-resonant metamaterials. The metamaterial is fabricated by closed-rings structure which shows an elliptical dispersion relation with a broadband magnetic response. We also experimentally achieve a broadband deep subwavelength resolution with singular media. The meta-lens is made of subwavelength metal/air layers which exhibit singular medium property over a broad band. Our work shows subwavelength resolution can be achieved using metamaterials with different dispersion relations. It may provide a new perspective to design the lens and make subwavelength imaging into application.