Supplementary Information

Three-dimensional broadband ground-plane cloak made of metamaterials

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The Supplementary Information includes: Supplementary Figures S1 to S7.

Contents:

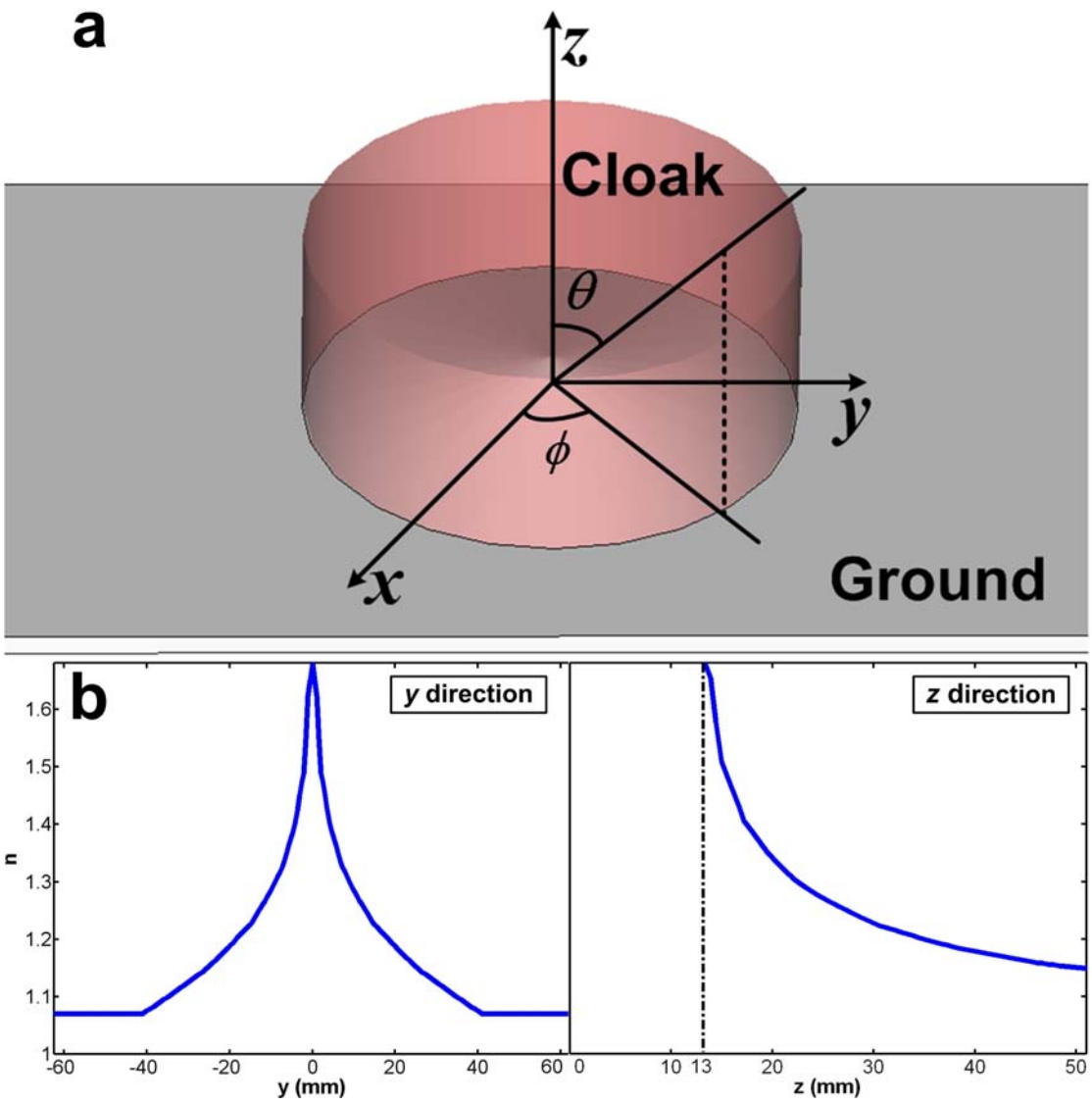

Figure S1 | The 3D ground-plane cloak and the corresponding index of refraction. a, The 3D ground-plane cloak in the Cartesian coordinate system. **b,** The distributions of refractive index along the *y* direction (*x*=0 and *z*=13 mm) and along the *z* direction (*x*=0 and *y*=0).

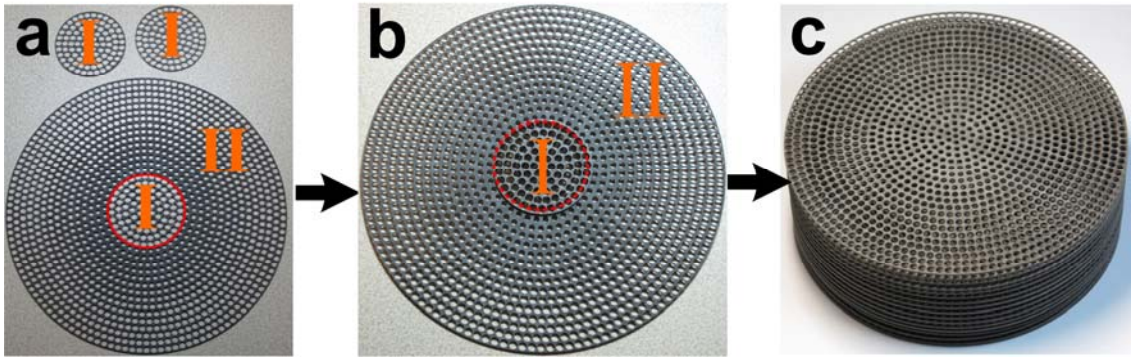

Figure S2 | The fabrication process of the 3D ground-plane cloak.

a, Three pieces of the F4B plates for the top layer. **b,** The generation of the top layer. **c,** The generation of the whole 3D ground-plane cloak.

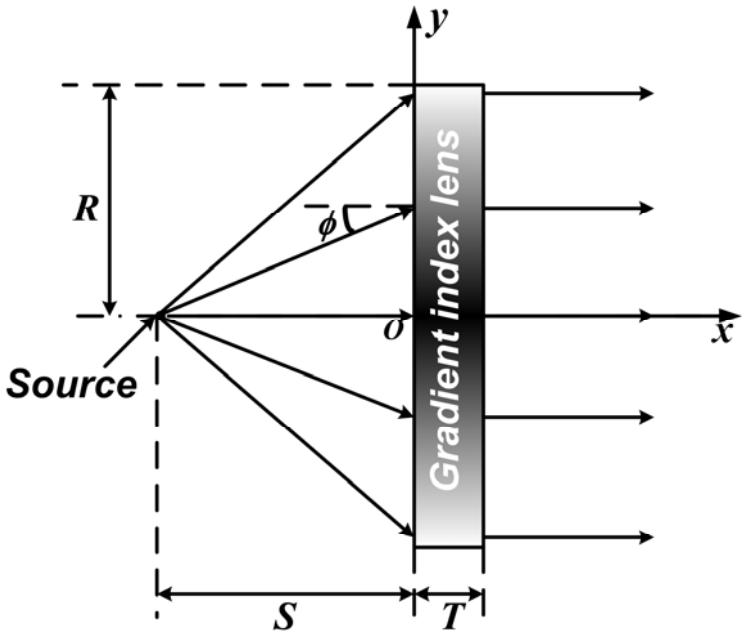

Figure S3 | The transformation of spherical waves excited by a point source to plane waves when propagating through a gradient-index lens.

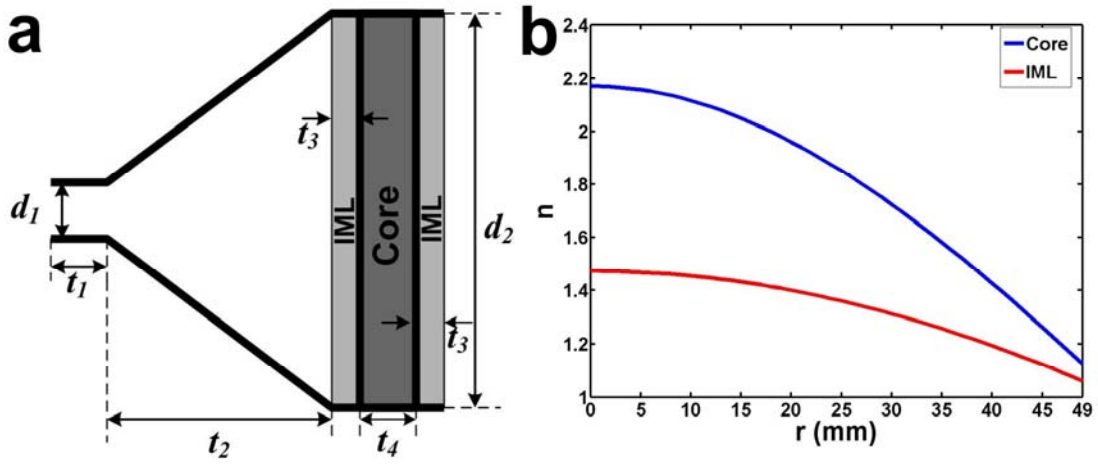

Figure S4 | The design of gradient-index lens antenna. a, The sketch of the gradient-index lens antenna, which is composed of a core layer and two IMLs. **b**, The refractive-index distributions of the core layer and IMLs.

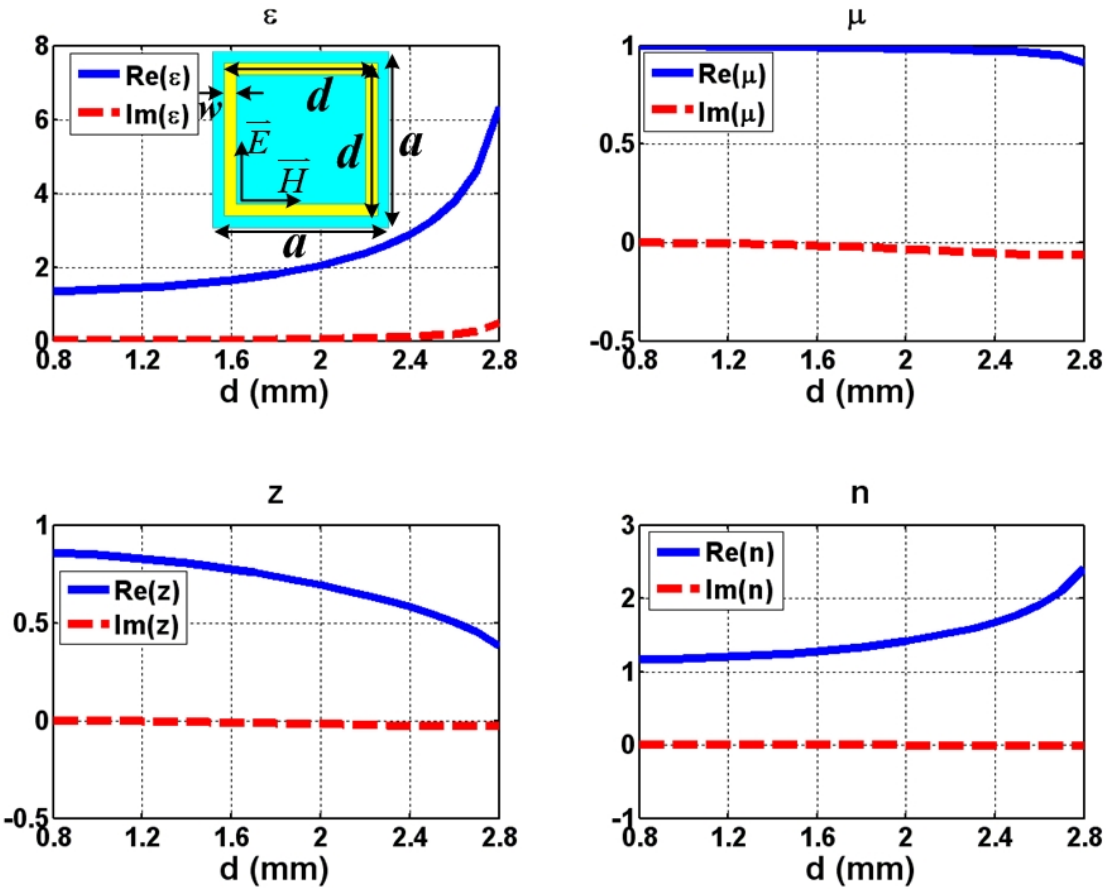

Figure S5 | The relationship between the effective material parameters and the dimensions d of the CSR structure at 10 GHz.

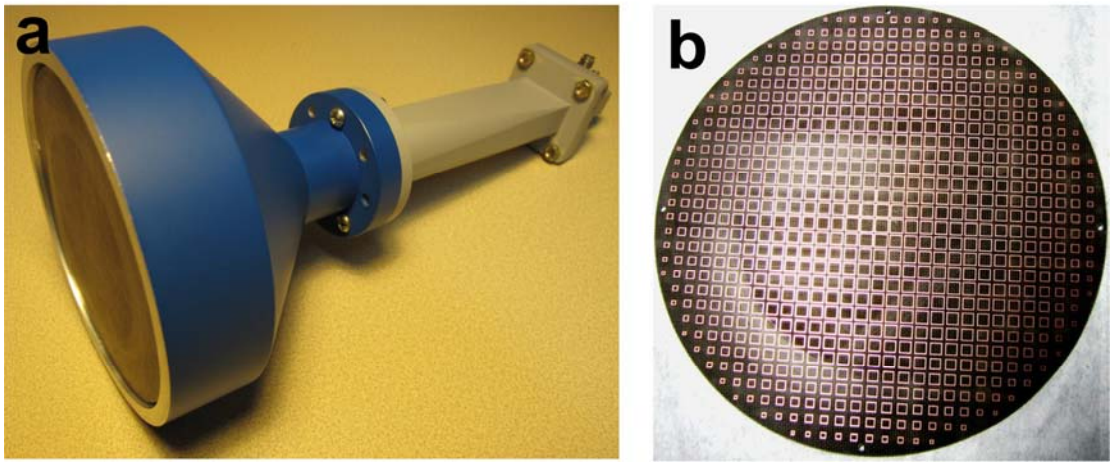

Figure S6 | The fabricated metamaterial lens antenna used in experiments. a, The photograph of the lens antenna. **b,** The photograph of the top layer of the lens antenna.

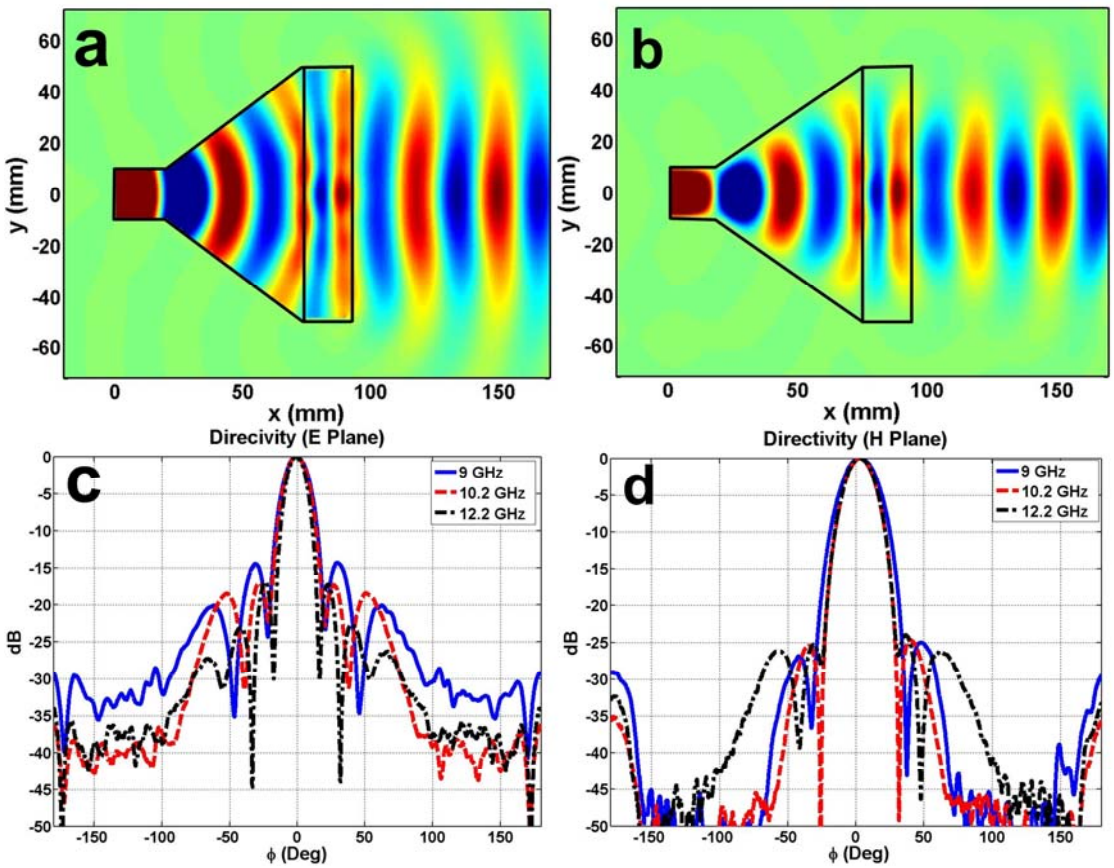

Figure S7 | The simulated electric-field distributions and measured radiation patterns of the metamaterial lens antenna. a, The simulated electric-field distribution on the E plane. **b,** The simulated electric-field distribution on the H plane. **c,** The measured far-field radiation patterns on the E plane. **d,** The measured far-field radiation patterns on the H plane.