Fabrication and analysis of 3D low THz metamaterials

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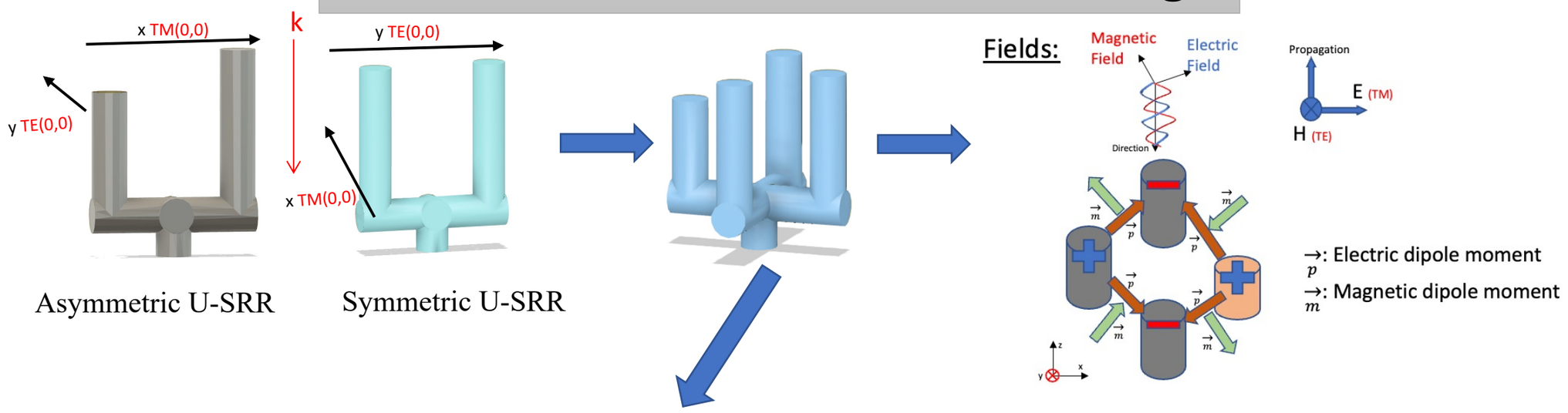
Introduction

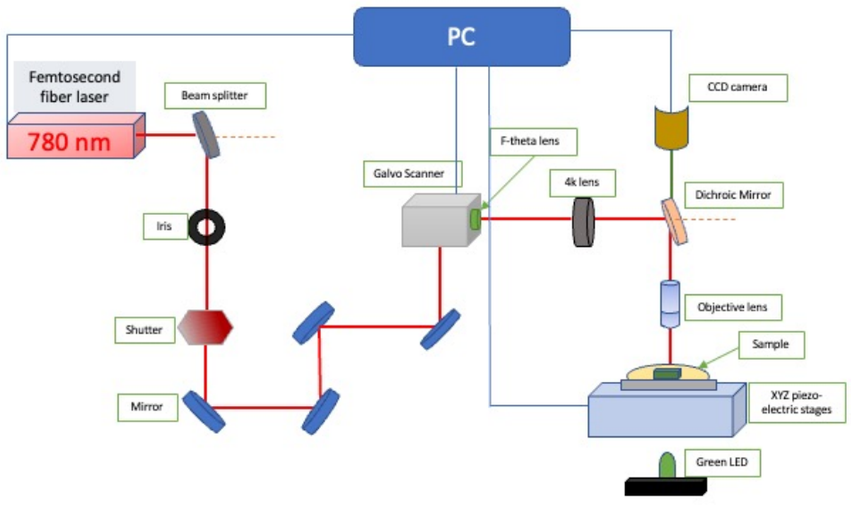
Metamaterials are artificially designed materials with properties that derives from their sub-wavelength structure. Optical metamaterials enable strong light-matter interaction over a broad range of the electromagnetic spectrum not achievable by any existing material in nature. Using MPL for metamaterial research is further underlined by demonstrating a procedure to process metamaterials operating at low THz.

Materials and methods

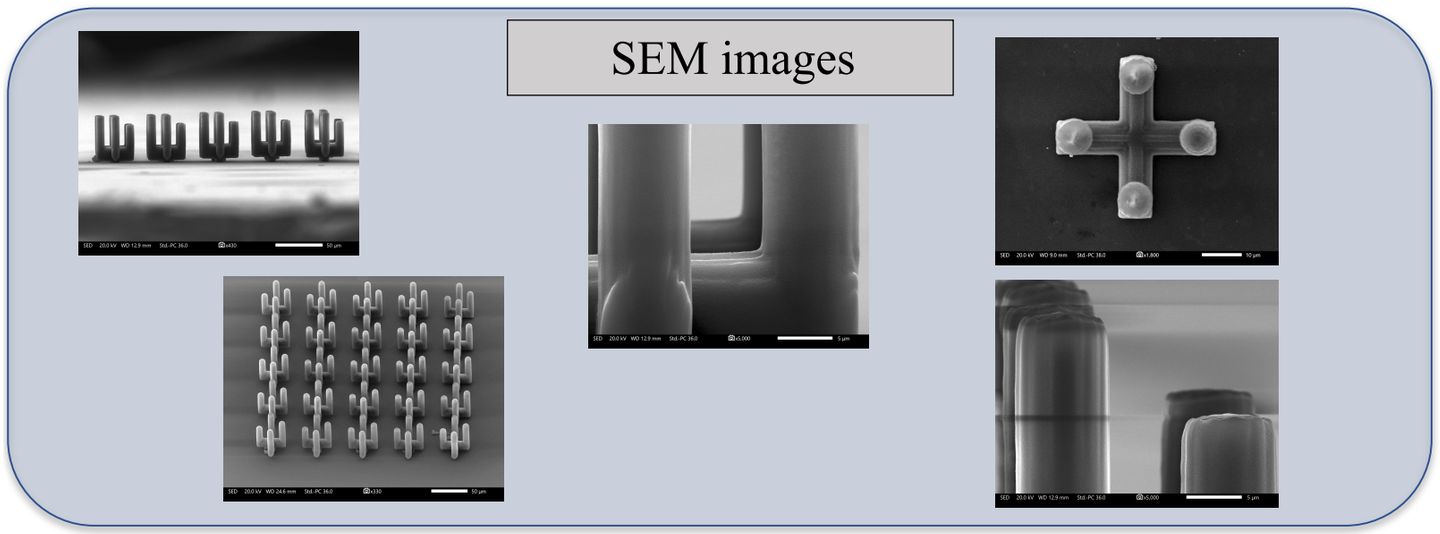
As a photosensitive material for the MPL an organic – inorganic photopolymer SZ2080™[1] was used. The structures were further processed using selective electroless plating to cover the polymer with silver via chemical procedure[2] in order to create a metallo-dielectric material. Simulations were done first with FDTD to define the optimal geometry and experimental measurements of S-parameters conducted after MPL process.

State of the art metamaterial design





SEM images



3D THz metamaterial filter for low THz

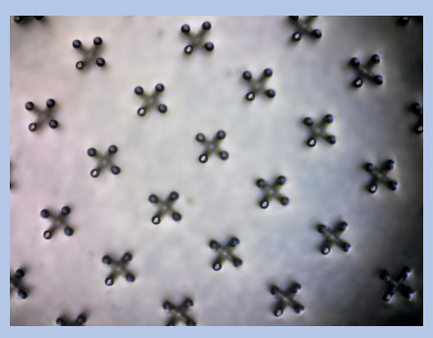


Fig 1. Image of metallic metamaterial.

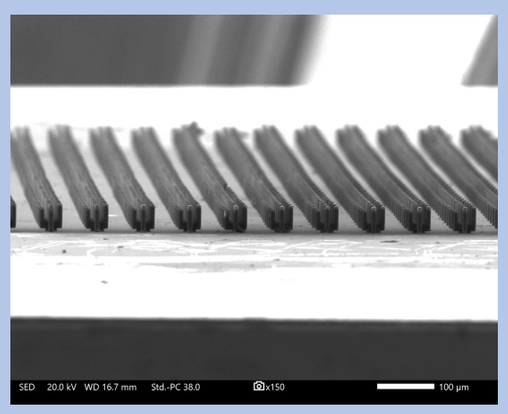


Fig 2. SEM image of fabricated metamaterial.

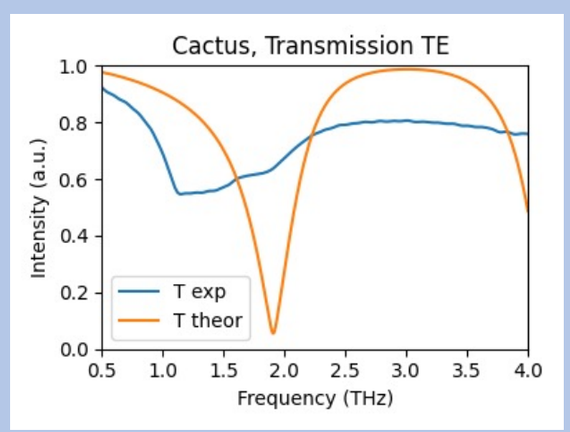


Fig 3. Results for TE mode

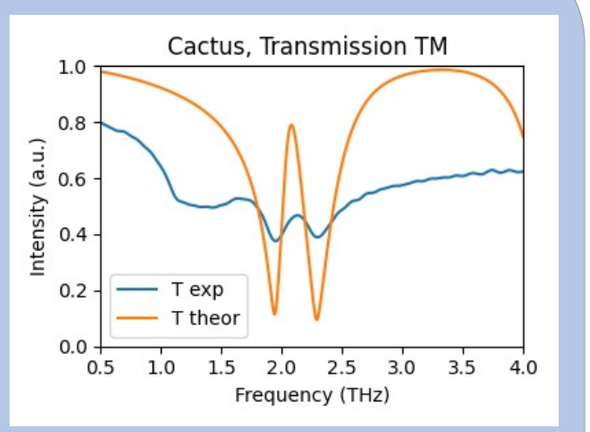


Fig 4. Results of TM mode.

Selective electroless silver coating

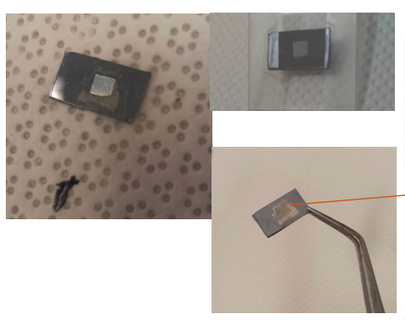


Fig 1. Images of the fabricated structure.

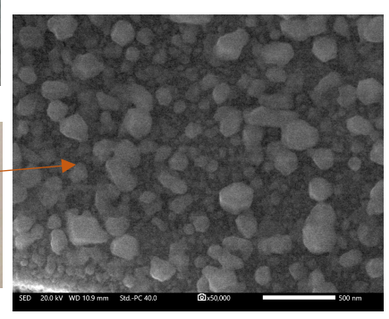
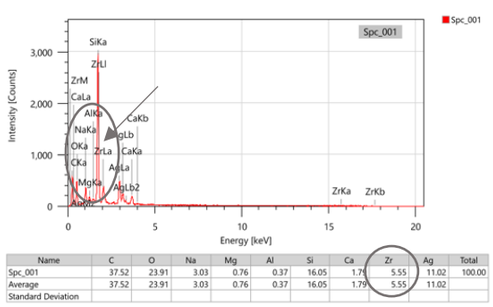
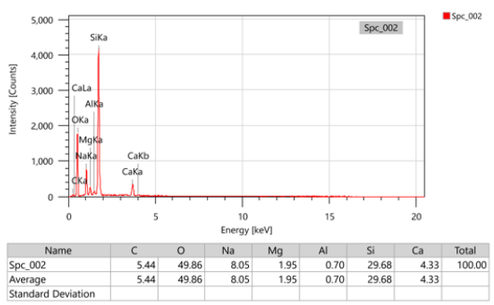


Fig 2. SEM image of silver coating.



Name	C	O	Na	Mg	Al	Si	Ca	Zr	Ag	Total
Spc_001	37.52	23.91	3.03	0.76	0.37	16.05	1.79	5.55	11.02	100.00
Average	37.52	23.91	3.03	0.76	0.37	16.05	1.79	5.55	11.02	
Standard Deviation										

Table 1. EDX measurement on the fabricated structure.



Name	C	O	Na	Mg	Al	Si	Ca	Total
Spc_002	5.44	49.86	8.05	1.95	0.70	29.68	4.33	100.00
Average	5.44	49.86	8.05	1.95	0.70	29.68	4.33	
Standard Deviation								

Table 2. EDX measurement on the substrate.

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References

1) Farsari, M., Chichkov, B. Two-photon fabrication. Nature Photon 3, 450–452 (2009). https://doi.org/10.1038/nphoton.2009.131
2) Sakellari, I., Yin, X., Nesterov, M. L., Terzaki, K., Xomalis, A., Farsari, M., Advanced Optical Materials 2017, 5, 1700200. https://doi.org/10.1002/adom.201700200

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