Extraordinary Transmission in Subwavelength Hole Arrays at 220 GHz

S. Kutznetsov[a], M. Navarro-Cia[b], M. Beruete[b], I. Campillo[c], and M. Sorolla[b]
[a] Budker Institute of Nuclear Physics, 630090 Novosibirsk, Russia
[b] Millimeter Wave Laboratory, UPNA, Campus Arrosadia, 31006 Pamplona, Spain
[c] CIC nanoGUNE Consolider, Paseo Mikeletegi 56, 301, 20009 Donostia, Spain

Abstract—**Here, we present for the first time experimental results of the phenomenon of extraordinary transmission through double periodic arrays of subwavelength holes at 220 GHz. Prototypes have been designed and fabricated by deposition of a thin Aluminum layer over a polypropylene wafer. These simulation results show a resonant total transmission at wavelengths close to the long period of the array. The transmission response measurements will be performed with a Millimeter Wave Quasioptical Vector Network Analyzer in the range between 40 GHz and 260 GHz. These results can give rise to interesting applications in the emerging Metamaterials field.**

I. INTRODUCTION

EXTRAORDINARY optical transmission (EOT) was demonstrated by measuring the optical transmission through 2D hole arrays consisting of subwavelength holes drilled in optically thick metallic films [1]. This pioneering work reopened the interest in perforated plates research [2]. As far as we know, the double periodic subwavelength regime in metallic hole arrays has not been previously explored in the millimeter wave and terahertz range. Also, the same phenomenon has been observed in the THz range for the case of highly dopped silicon wafers [3].

II. RESULTS

The design has been performed by CST Microwave Studio electromagnetic software and the prototype has been fabricated following the parameters and materials given in Fig. 1.

Simulation results shown of Fig. 2. are encouraging for negative refraction metamaterials in the terahertz and optical frequency ranges [4].

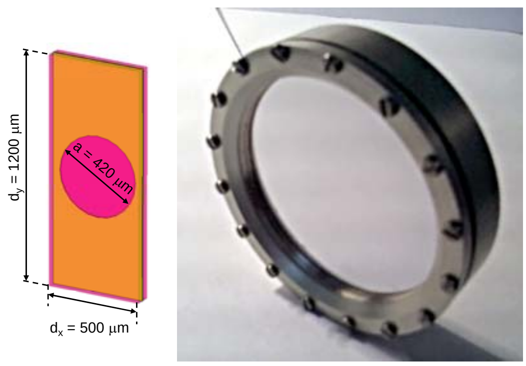

Fig 1. Schematic of unit cell and picture of the dielectric wafer with, a = 420 µm, d_x = 500 µm, d_y = 1200 µm, the thickness of the polypropylene wafer (∅ 62 mm) is 15 µm and the Al layer is 0.5 µm.

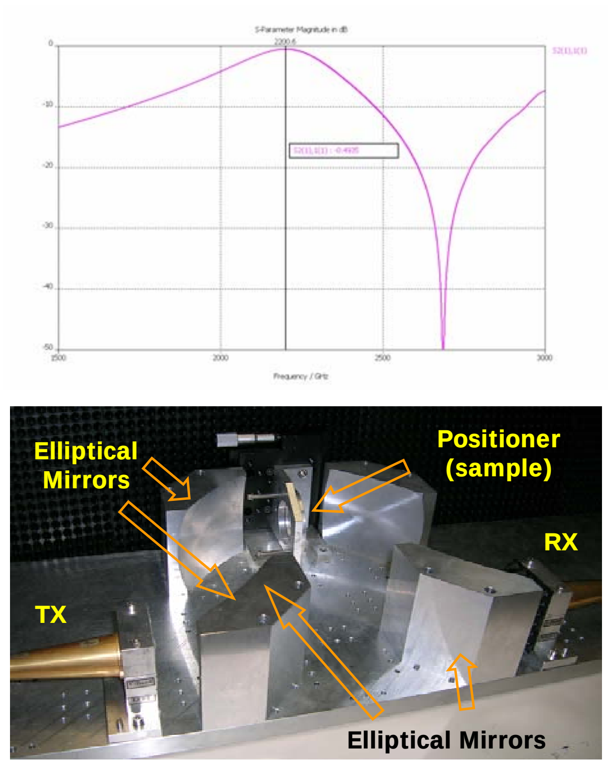

Fig 2. Simulation result of the transmission parameter and experimental set-up.

ACKNOWLEDGEMENTS

This work has been supported by the Ministerio de Educación y Ciencia through the project TEC2005-06923-C03-01.

REFERENCES

[1] T. W. Ebbesen, H. J. Lezec, H. Ghaemi, T. Thio, and P. A. Wolf, "Extraordinary optical transmission through sub-wavelength hole arrays," Nature 391, pp. 667-669 (1998).

[2] M. Beruete, M. Sorolla, I. Campillo, J.S. Dolado, L. Martín-Moreno, J. Bravo-Abad and F.J. García-Vidal, "Enhanced millimeter wave transmission through subwavelength hole arrays.", *Optics Letters*, Vol. 29, No. 21, pp. 2500-2502, (Nov. 2004).

[3] J. Gómez Rivas, C. Schotsch, P. Haring Bolivar, and H. Kurz, "Enhanced transmission of THz radiation through subwavelength holes", Physical Review B 68, 201306(R) 2003.

[4] M. Beruete, M. Sorolla, and I. Campillo, "Left-handed extraordinary optical transmission through a photonic crystal of subwavelength hole arrays," Opt. Express 14, pp. 5445-5455, (2006).

978-1-4244-2120-6/08/$25.00©IEEE.