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Impedance measurements in $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$ thin films for uncooled THz bolometers

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Abstract—We present preliminary results on the fabrication and impedance measurement of loads made of $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$ (LSMO) thin films on SrTiO_3 buffered high resistivity silicon substrates. These loads will be used in uncooled mm-wave and THz bolometers based on LSMO.

I. INTRODUCTION

The manganite composition $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$ (LSMO) is an example of promising material for the manufacturing of uncooled bolometers since it shows a strong variation of electrical resistivity as a function of temperature close to 300 K. Using buffer layer(s) epitaxial LSMO thin films can be grown on silicon substrates. These films have a very low noise level compared to other resistive materials such as semiconductors and other oxide-based materials. Thanks to silicon micromachining techniques it is possible to fabricate sensitive sensors working at room temperature with a very low level of noise for targeted applications such as bolometers, thermal sensors or gas sensors [1-3]. In this paper, we will focus on the preliminary results on the impedance characterizations of 60nm LSMO thin films deposited on SrTiO_3 buffered high resistivity Si substrates in order to act as a load for a THz antenna.

II. SAMPLES

A 20 nm thick SrTiO_3 (STO) layer was deposited by Molecular Beam Epitaxy (MBE) on 3-inch high-resistivity Si substrate. The 55nm-thick LSMO layers were then deposited by pulsed laser deposition (PLD) on $10 \times 10 \text{mm}^2$ STO/Si pieces. About 200 nm thick gold layers were deposited by ion beam etching to form electrical contact pads after a first laser lithography step followed by chemical etching in KI. A second laser lithography step was used to pattern LSMO layers by ion beam etching. Fig.1 presents the electrical resistance versus temperature characteristics of the as-deposited LSMO/STO/Si layer.

III. RESULTS

Electrical measurements using transmission line method (TLM) and four probes designs have been performed on different geometries and samples (Fig. 2). The measured electrical resistivity and specific contact resistance are around few $\text{m}\Omega \cdot \text{cm}$ and few $10^{-4} \text{ Ohm} \cdot \text{cm}^2$ at 300 K.

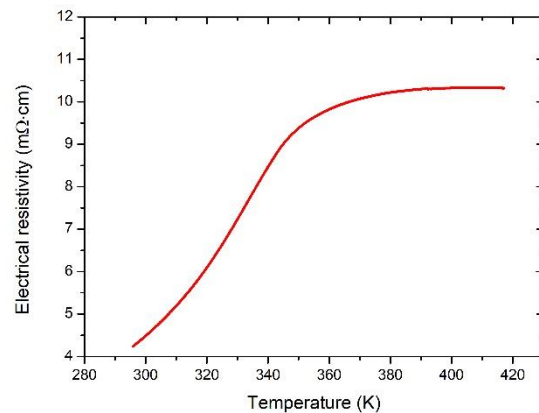


Fig. 1. Electrical resistance versus temperature characteristics of the as-deposited 55 nm thick LSMO/STO/Si layer.

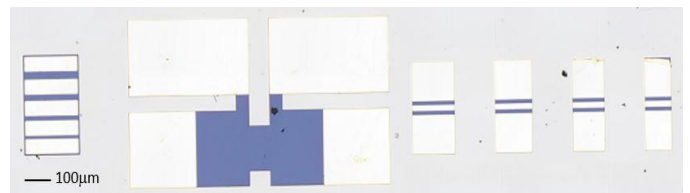


Fig. 2. Image of typical TLM, 4 probes, and CPW design.

RF measurements were made on the coplanar waveguide (CPW) lines designed to have a characteristic impedance of 50Ω without LSMO in the slots. Figure 3 shows the impedance of a $120 \mu\text{m}$ -long CPW structure (with LSMO) measured with a vector network analyzer (VNA) with coplanar probes. The blue curve shows the impedance variation in the 0-110 GHz range at 20°C . The real part varies between 75Ω (DC) and 40Ω (110 GHz). Green, black, purple, yellow and brown curves shows the impedance at $30, 40, 50, 60$ and 70°C in the 0-50 GHz range. As expected the real part of the impedance shifts progressively to higher values as the temperature increase (the temperature coefficient of the DC resistance of LSMO is positive). At 70°C the real part varies between 150Ω (DC) and 80Ω (110 GHz) which is two times the values at room temperature. The imaginary part is below -40Ω .

It is thus possible to fabricate matched loads for mm-wave and THz bolometers. In future works, LSMO loads will be integrated with antennas for large bandwidth bolometers. Further results will be shown at the conference.

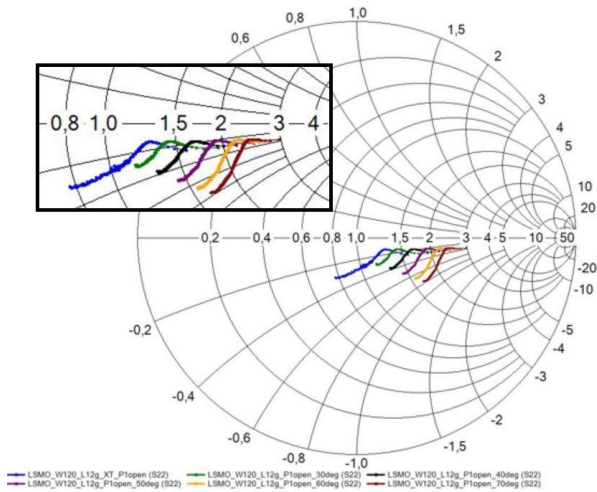


Fig. 3. Experimental results of VNA impedance measurements of CPW structures. Blue: 0-110 GHz, 20°C. Green: 0-50 GHz, 30°C. Black: 0-50 GHz, 40°C. Purple: 0-50 GHz, 50°C. Yellow: 0-50 GHz, 60°C. Brown: 0-50 GHz, 70°C.

REFERENCES

- [1] L. Méchin, S. Wu, B. Guillet, P. Perna, C. Fur, S. Lebargy, C. Adamo, D.G. Schlom, J.M. Routoure, "Experimental evidence of correlation between $1/f$ noise level and metal-to-insulator transition temperature in epitaxial $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$ thin films", *J. Phys. D: Appl. Phys. - Fast Track*, Communication 46 202001 (2013).
- [2] S. Liu, B. Guillet, C. Adamo, V.M. Nascimento, S. Lebargy, G. Brasse, F. Lemarié, J. Elfallah, D.G. Schlom, L. Mechin, "Free-standing $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$ suspended micro-bridges on buffered silicon substrates showing undegraded low frequency noise properties", *J. Micromech. Microeng.*, 29, 065008 (2019)
- [3] V. M. Nascimento, L Méchin, S. Liu, A. Aryan, C. Adamo, D. G. Schlom, B. Guillet, "Electro-thermal and optical characterization of an uncooled suspended bolometer based on an epitaxial $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$ film grown on $\text{CaTiO}_3/\text{Si}^i$ ", *J. Phys. D: Appl. Phys.* 54 055301 (2021)