Optimization of Narrow Width Effect on Titanium Thermistor for Room-Temperature Antenna-Coupled Terahertz Microbolometer Fabrication

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Microbolometer is a radiation detector for infrared (IR) and terahertz (THz) waves. One of the important parameters for microbolometer fabrication is the temperature coefficient of resistance (TCR) of the thermistor, as the responsivity is proportional to the TCR. Also it is expected that the noise equivalent power (NEP) is inversely proportional to the TCR. The merit of the use of metallic resistor is the low noise, dominated by shot noise and thermal noise, and hence device performance can directly get benefit from the improved TCR. We have reported the fabrication of room-temperature antenna-coupled microbolometer for 1-THz region with a responsivity: 90 V/W, NEP: 4.5×10^{-10} W/Hz$^{0.5}$, f_c: 7 kHz. Considering the importance of TCR, the narrow width effects on the TCR and resistivity on two different substrates (SiO_2/Si and SiN_X/SiO_2/Si) for titanium (Ti) thermistor is investigated and correlated with reduced grain size.

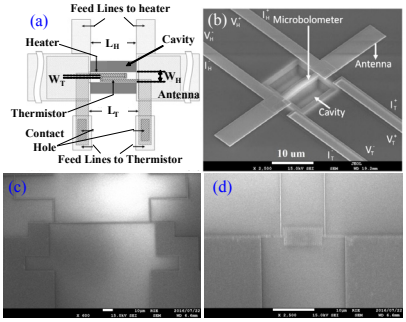

Fig. 1 (a) Schematic diagram of the antenna-coupled Ti-microbolometer (b) SEM image of microbolometer fabricated by electron beam lithography (EBL). (c) Straight and (d) meander devices fabricated for measurement of the width effect on the thermistor.

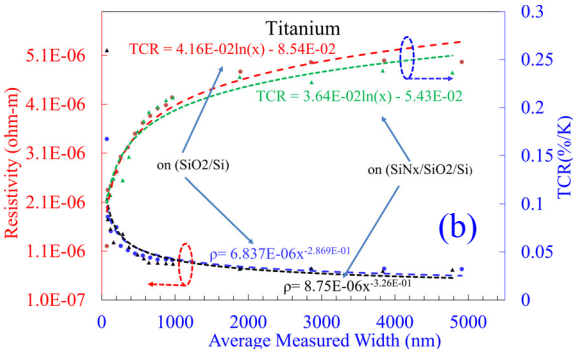

Fig. 2 Temperature coefficient of resistance (TCR) and resistivity (ρ) with the variation of average measured width for Ti thermistor with two different substrates and straight structure.

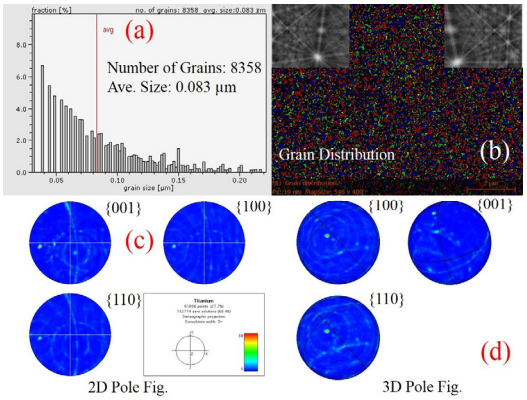

Fig. 3 (a) & (b) Average grain size from electron backscatter diffraction (EBSD) for Ti film (150 x 150 µm area), with local diffraction patterns (inset). (c) 2D & (d) 3D pole figures from EBSD.

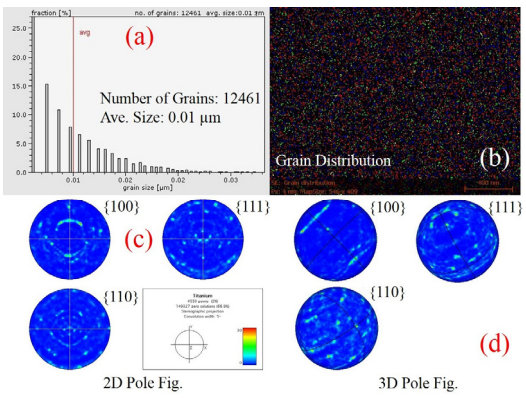

Fig. 4 (a) & (b) Average grain size from EBSD for a Ti nanowire with width (DW) =1000 nm. (c) 2D & (d) 3D pole figures from EBSD.