Study on NEP for optimization of THz Antenna-Coupled Ti Microbolometers with Straight and Meander Shaped Thermistors

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Room-temperature antenna-coupled Ti microbolometers with straight wire shaped thermistors (lengths - 25, 50, 10 μm and width - 0.2 μm) and meander shaped thermistors (length - 48.7 μm and width - 0.2 μm) were fabricated and analyzed. Straight and meander shaped thermistor structures are shown in Fig.1 (a) and (b), respectively. Sensitivity is one of the important parameter for optimizing the microbolometer characteristics, which can be analyzed in terms of noise equivalent power (NEP). To estimate the NEP, voltage noise was measured for the microbolometers with the use of dynamic signal analyzer over a frequency range of 10 Hz -10 kHz. To enhance the bolometer performance maximum allowable bias current was applied at the thermistors. The measured spectra shown in Fig.2 (a) exhibits both frequency and bias current dependence. The bias current dependence can be clearly seen as the noise voltage gradually increases with the increased bias current. Fig.2 (b) represents the dependence of voltage noise and bias current on lengths of the thermistor. Since the noise voltage is direct proportional of resistance, the longest bolometer shows larger noise voltage than the others, though its applied bias current is small. Trade-off between NEP and responsivity (R_v) has been shown in Fig.2 (c).

NEP was estimated from the measured noise voltage at 100 Hz and responsivity under same bias current. For the straight wire thermistors the minimum NEP of 5.91 x 10^{-11} $W/\sqrt{Hz}$ was obtained for the longest device (length - 100 μm) which has the largest responsivity of 976 V/W. Similarly, for meander shaped bolometer which has the responsivity of 286.4 V/W, the calculated NEP is 1.75 x 10^{-10} $W/\sqrt{Hz}$. Even though, the length of the meander thermistor is large, due to its structure it is possible to reduce the entire bolometer length. By narrowing the thermistor width and increasing the length of meander thermistor can be the promising detector for antenna-coupled bolometers.

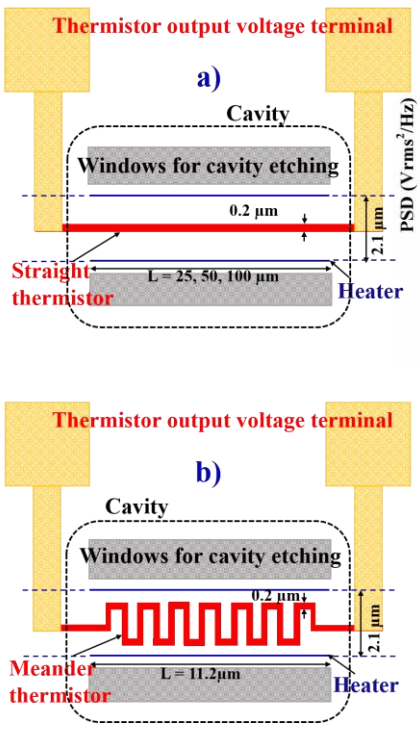

Fig.1 Microbolometer structure a) Straight wire b) Meander thermistor

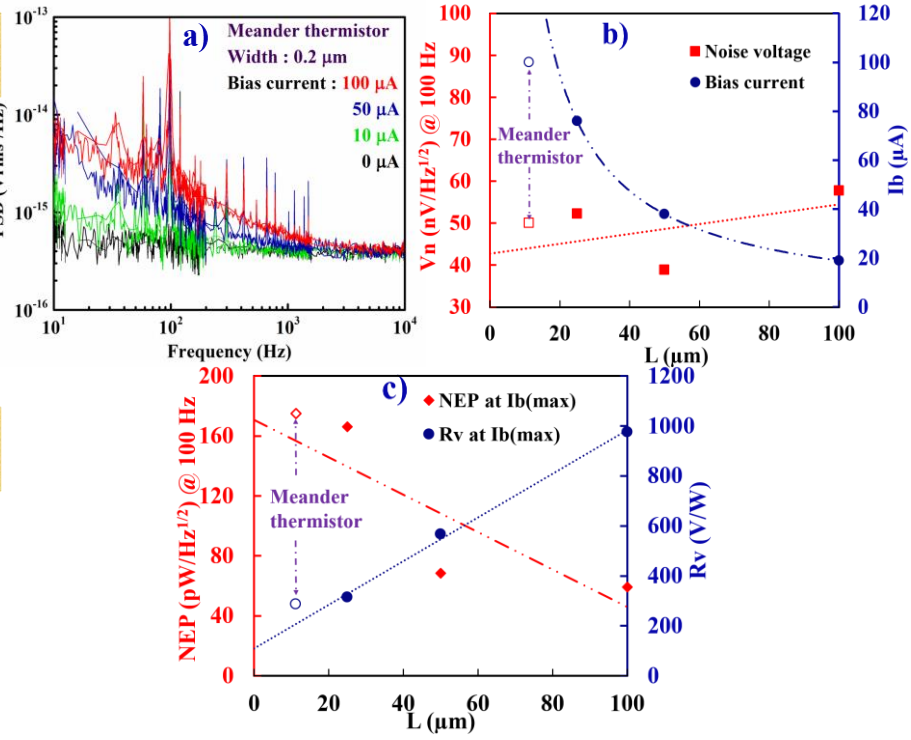

Fig.2 (a) Noise power spectral density of 0.2 μm wide meander thermistor with respect to bias current (b) V_n and I_b dependence on bolometer length (c) NEP and Responsivity versus length