Fabrication and Characterisation of Series YBCO Step-edge Josephson Junction Arrays

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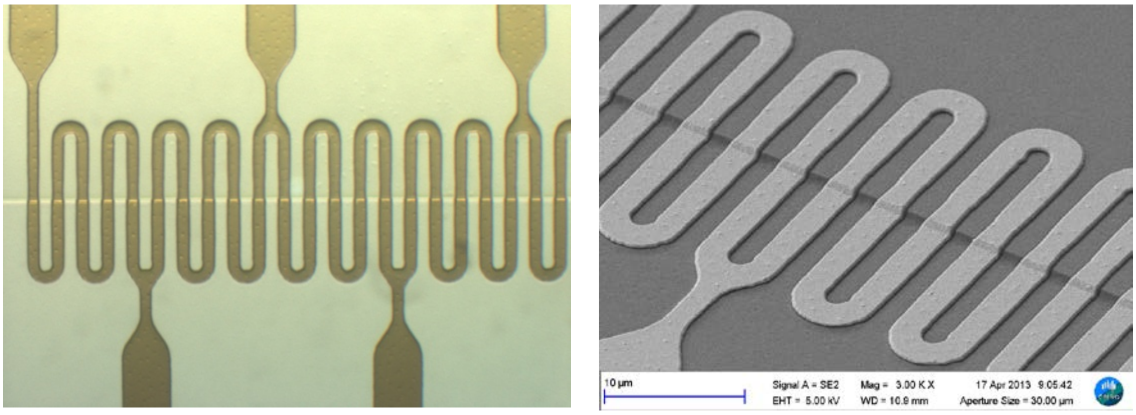
September 22, 2014 (HP86). The unique property of the Josephson junction to act as both a generator and a detector of high-frequency electromagnetic waves has been long recognised, and its performance in both these roles can be enhanced by using junction arrays. Large arrays of low-T_c superconducting (LTC) Nb-AlOx-Nb junctions have been well developed and applied in many applications such as voltage standards, phase-locked Josephson-oscillation, SQUID and SQIF array RF receivers and metamaterials. Fabricating large arrays of high-temperature superconducting (HTS) junctions has proven to be challenging due to the difficulty of precisely controlling the Josephson junction parameters, a result of the very short coherence lengths and oxygen-sensitive nature of the HTS materials. Nevertheless, progress has been made in fabricating large array (from tens to many thousands) HTS junctions; most notably using the ion-beam-damage method [1] and bi-crystal substrates [2]. The mentioned two techniques, however, have some limitations; the former has relatively low R_n or I_cR_n values, and the latter has restriction in making large 2D arrays or complex geometries.

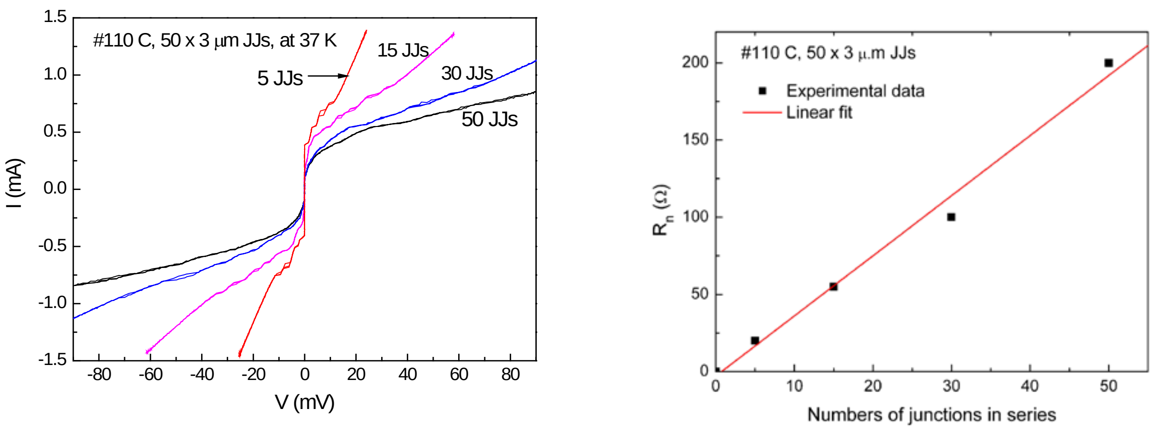
Recently we reported the fabrication and characterisations of YBCO step-edge Josephson junction arrays in a series configuration [3]. The junction arrays were fabricated using CSIRO YBCO step-edge junction technology [4, 5], which, owing to the flexibility of locating the junctions anywhere on the chip, makes it attractive for implementation of multiple devices and circuits. Arrays of 50 junctions in series (Fig. 1) were fabricated and the DC current-voltage (I-V) characterisations were studied at various temperatures; obtained via either using a liquid He dewar or a commercial cryocooler. Large junction normal resistances (several hundred Ωs) were obtained from the series junction arrays (Fig. 2). In this report, eight array samples of 50 junctions with widths between 2 and 4 μm, totalling 400 junctions, were fabricated and tested; no electrically open or short-circuited junctions were found (i.e. a 100% yield of working Josephson junctions), demonstrating good fabrication reliability. Studies on the junction critical current spread within an array, magnetic field dependence of the critical current and microwave responses of the arrays are also presented in this paper, which has been published in *Supercond. Sci. Technol.* **27** (2014) 095995 (7pp), DOI:10.1088/0953-2048/27/9/095005. While this publication presents the first results on 50-junction series arrays, we have also recently fabricated large 2-D array containing thousands of step-edge junctions.

A detailed study of the array junction critical current variations and their dependence on the junction width and temperature is reported in another companion paper [6] published in *Supercond. Sci. Technol.* **27** (2014) 055011 (7pp), DOI:10.1088/0953-2048/27/5/055011.



(a) (b)

Fig. 1. A photograph (a) and a SEM micrograph (b) of a 2-µm wide YBCO step-edge series junction array.



(a) (b)

Fig. 2. (a) IVCs of a 3 μm array of different JJ numbers at 37 K and (b) the R_n value as a function of the number of step-edge junctions where the slope gives approximately average 4 Ω per junction.

References

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