

SILICON NANOWIRE FIELD EMITTERS WITH INTEGRATED EXTRACTION GATES MADE FROM BENZOCYCLOBUTENE AS AN INSULATOR

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Silicon nanowire emitters on pillars fabricated from silicon (1-10 Ohm*cm, n-type) with aligned extraction grids show good emission characteristics in terms of achievable emission current and electron transmission [1]. However, grid assembly and alignment are a manual single-chip process. Alternatives such as integrated gate electrodes mitigate this issue [2]. Furthermore, these gates reduce the extraction voltages required and increase the electron transmission, while allowing a tighter packing of emitters, which increases the utilisation of the available chip space. Benzocyclobutene (BCB) [3] is suitable as an insulator and gate electrode support, as it can be easily spun onto the already fabricated emission pillars and then thermally cured. The spatial efficiency of the emission array was increased by switching from a square to a hexagonal packing [1] of the emitters and reducing the emitter spacing from 50 µm to 40 µm (Fig. 1). The extraction gates were fabricated and aligned by photolithography, followed by metallisation with lift-off and subsequent removal of the BCB around the emitters by plasma etching (Fig. 2).

An emission current of 0.4 mA was measured for 30 minutes at an extraction voltage of 250 V and an anode voltage of 500 V. The electron transmission through the gate averaged 99.61%

In our conference contribution we will describe the fabrication process and the emission performance of these field emission arrays in more detail.

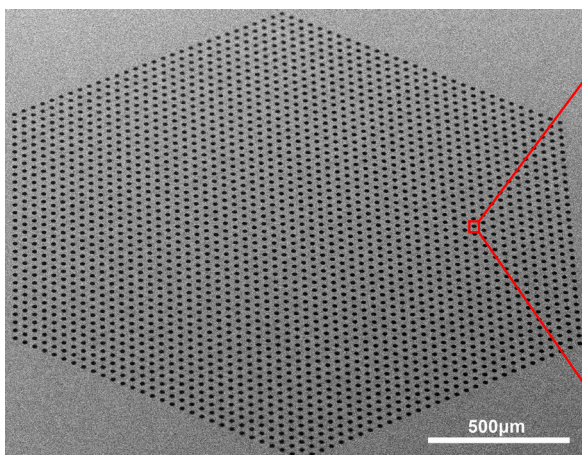


Fig. 1. SEM of an entire emission array. The individual emission pillars are arranged in a hexagonal densest packing with a spacing of 40 µm. There are 4219 emission pillars per array. The array's area is 5.5 mm².

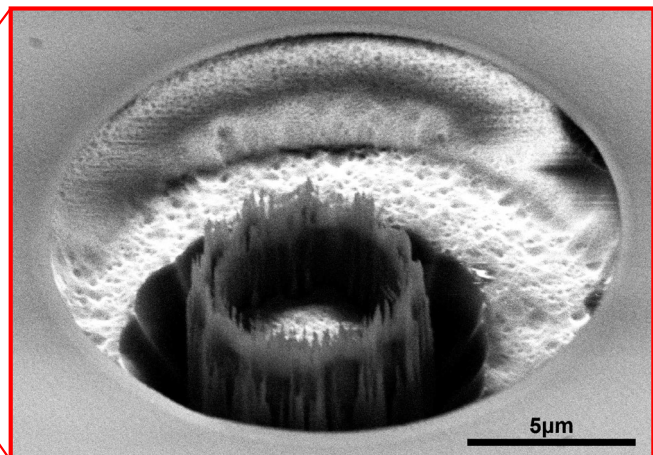


Fig. 2. SEM of a single silicon nanowire field emitter crown on its tubular pillar covered in BCB. The emitter is centered in its gate opening, which has a diameter of 17 µm. The emitter's diameter is 5 µm and its height is approximately 30 µm. The BCB was selectively removed in the vicinity of the emission pillar by plasma etching, after the gate electrode was structured by a lift-off process.

References

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