SILICON FIELD EMITTERS FABRICATED BY SAW-DICING AND TMAH ETCHING

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ABSTRACT

Recently a vacuum-sealed field emission electron gun [1] was introduced. Within the sealed housing a pressure below 10^{-3} mbar is achieved. For electron field emission in such a harsh environment a simple producible and resistant field emission array (FEA) is needed. For most recent FEAs (b-Si field emitter [2]) an expensive and maintenance-intensive cleanroom with lithography is required. In this contribution the fabrication of FEAs is realized with a wafer dicing saw and anisotropic wet chemical etching by tetramethylammonium hydroxide (TMAH).

As a first step an array of square pillars with an adjustable height are formed by the dicing saw on a silicon (antimony-doped 100-Wafer with a resistivity of 0,01-0,02 Ωcm) chip, whereby the sidewall orientation is parallel to the [100]-planes. In the second step the whole chip with the pillars is dipped into 20% TMAH solution until tips as shown in Fig 1. are formed. The wide pyramid on the bottom is formed by planes (poss. {331} and {221}) which are slowly etched in comparison to other planes [3,4]. The sharper tip on top of the pyramid is formed by interaction of a variety of fast etching planes (poss. {411}, {311} and {310}) and crystal defects. This is in good agreement to the theory that local minima or maxima in the etch rates dominate the appearance of etched surfaces [4]. The mean and standard deviation of the emission current of 5 consequential voltage cycles of such an FEA is shown in Fig 2. Onset voltages of approx. 250 V and currents of about 10 µA for extraction voltages lower than 1000 V are obtained whereby the distance between the extraction grid and the FEA-tips is about 110 µm.

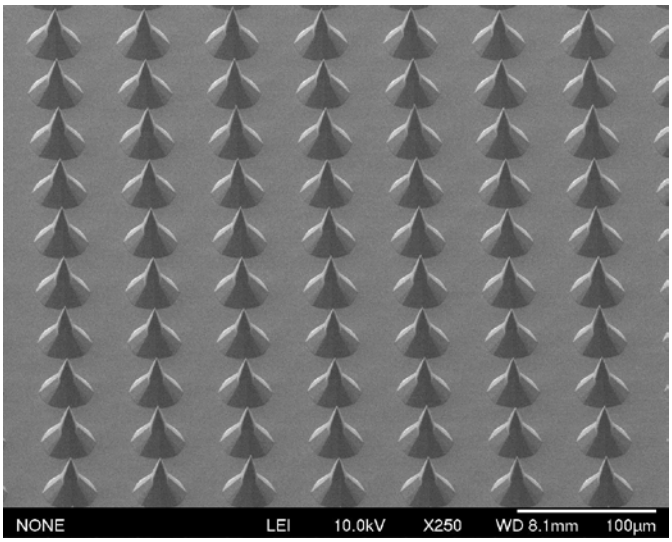

Fig. 1. Scanning electron micrograph showing an array of tips after sawing and etching

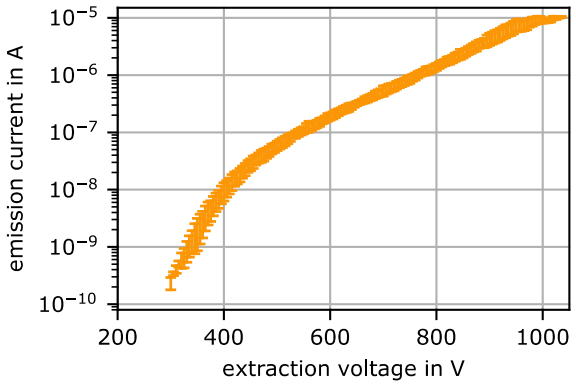

Fig. 2. Current-Voltage Characteristics of a saw diced FEA.

References

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