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PARALLEL NANOGAP FABRICATION WITH NANOMETER SIZE CONTROL USING III-V SEMICONDUCTOR EPITAXIAL TECHNOLOGY

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A reproducible and full-wafer compatible fabrication process for adjustable contact electrodes separated several nanometers is a major technological challenge. Until now, several approaches have been developed [1-6] to achieve a controlled parallel process for patterning multiple nanogaps with controlled sizes. In this letter a novel method for parallel nanogap fabrication using strained epitaxial III-V beams is presented. The process is highly reproducible, allows parallel fabrication and highly accurate gap size control. The beams are fabricated from MBE grown (GaAs/GaP)/AlGaAs strained heterostructures, standard e-beam lithography, and wet etching. During the wet etching process, the relaxation of the accumulated stress at the epitaxial heterostructure produces a controlled beam breakage at the previously defined beam notch. After the breakage, the relaxed strain is proportional to the beam length, allowing nanogap size control. The starting structure is similar to a mechanically adjustable break junction but the stress causing the breakage is, in this case, built-in the beam. This novel technique should be useful for molecular-scale electronics devices.

An array of four beams with different lengths (from 4 to 10 μm) has been designed and fabricated and it is shown in Fig. 1.a). The formed nanogaps for different cantilever lengths are shown in Fig. 1.b). Fig. 1.c) shows the nanogap size d as a function of the cantilever length L. A linear relation is obtained. These results clearly show that the nanogap formation mechanism developed in this work allows us to control the nanogap size by changing the III-V heteroepitaxial beam length, getting nanogap sizes as low as 5 nm.

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Figures:

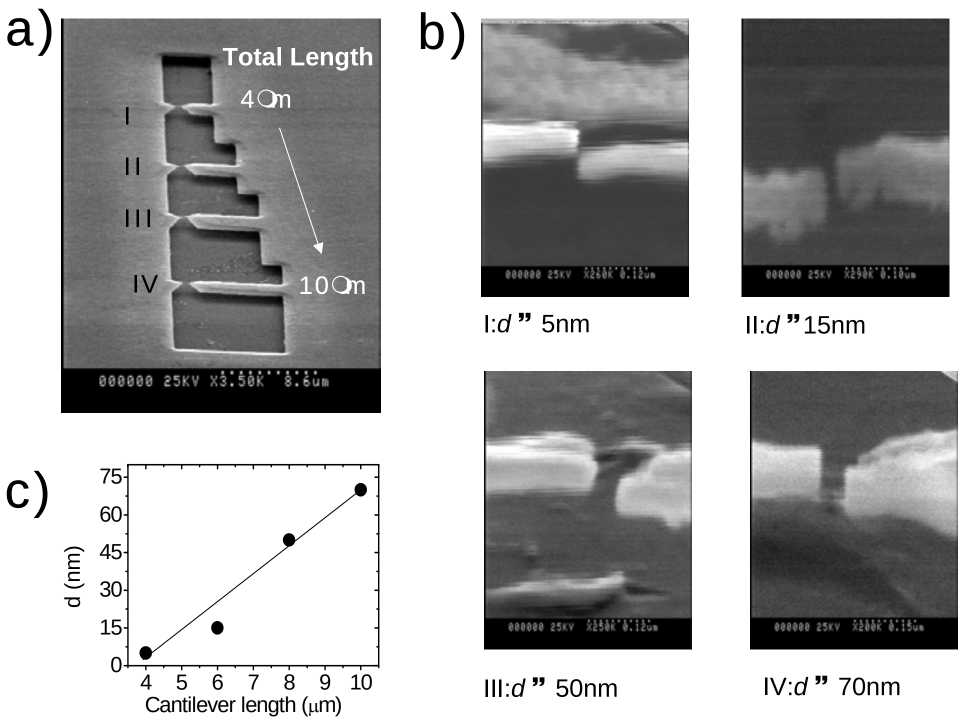

Figure 1) a) Scanning electron microscope image of a four-junction array in which the length of the beam is designed from 4 to 10 μm. The device is tilted 45 degrees during the image acquisition. b) Side view of the different nanogaps that correspond to different beam lengths. The device is tilted 90 degrees during the image acquisition. c) Nanogap size *d* as a function of the beam length *L*.