COMPARISON OF ETCH PROCESSES FOR PATTERNING HIGH ASPECT RATIO AND NANOSCALE FEATURES IN SILICON

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This paper compares two leading techniques for the deep etching of silicon - the "Bosch" process and a cryogenically cooled process. Latest results for these techniques will be reviewed as well as the growing importance of nanoscale etching of silicon using cryogenically cooled processes.

Bosch Process

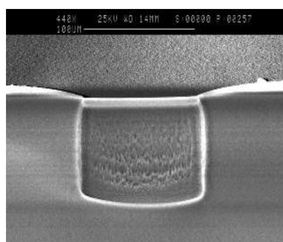

Figure 1: 100µm deep etch at 17µm/min

A typical result for a bulk silicon etch is shown in figure 1.
A near vertical profile was achieved with an etch rate of 17µm/min.

By controlling the gas switching ratios, pressure and power, high rate processing up to 10µm/min through wafer etches can be achieved with smooth sidewalls. (Figure 2-4)

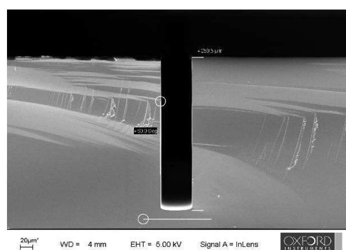

Figure 2: Through wafer etch with smooth sidewalls

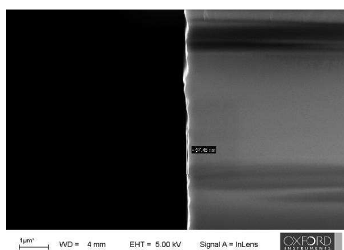

Figure 3: Smooth sidewall

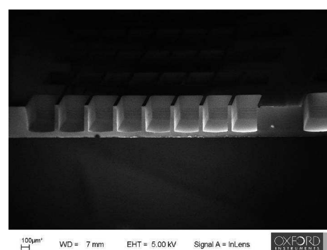

Figure 4: Through wafer etch

Cryo Process

The basic cryo process has not changed over the years with etch rates, depending on the aspect ratio, typically greater than 2µm/min. (Figure 5 and 6). Cryo etching also delivers very smooth sidewalls and the ability to create positive profiles. (Figure 7)

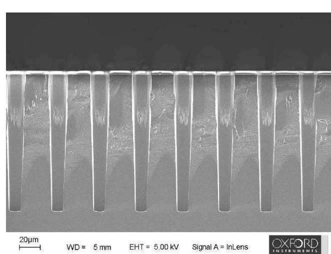

Figure 5. Via etch

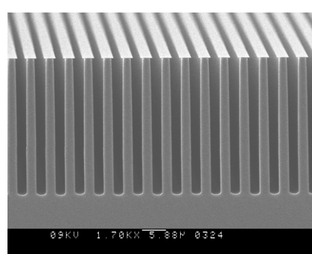

Figure 6. Trench etched at >3µm/min

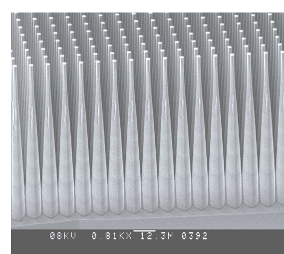

Figure 7. Tapered profile

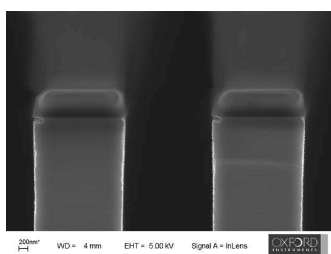

Figure 8: Notch at mask/Si interface

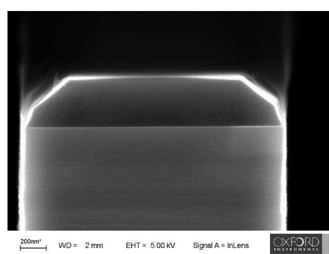

Figure 9: Elimination of notch

A recent advance in cryo etching has been the elimination of the notch at the mask/Si interface. (Figure 8).

This has been eliminated by the use of both hardware and ramping of gas ratios during the initial stages of the process. (Figure 9)

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