FTIR In Situ Depth Measurement System for DRIE

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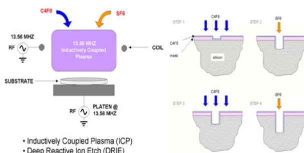
INTRODUCTION

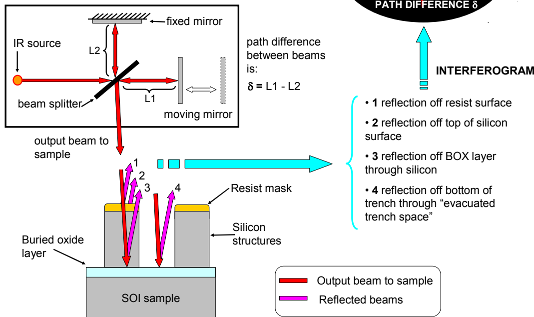
An *in situ*, real time metrology system was developed, integrated, and tested for measuring the depth of MEMS structures during deep reactive ion etch (DRIE) processing in The Microlab's STS. DRIE is promising technology in that it is capable of delivering MEMS devices at a relatively low cost, but a major difficulty with this type of processing is the control of etch depth. Our research shows that it is possible to monitor the etch depth of MEMS features via a specialized FTIR (Fourier Transform Infra Red) system *during* the DRIE process.

DRIE

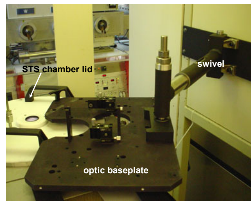
Deep Reactive Ion Etching uses alternating cycles of etch (SF6) and passivation (C4F8) to produce high aspect ratio profiles in silicon. Basic schematics of the system and etch process are shown to the right.

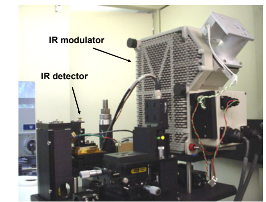


BASIC PRINCIPLE



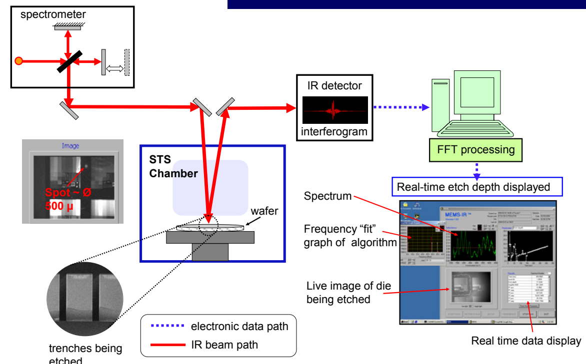
OPTIC SWIVEL PLATE





An optic plate swivel system was designed and built (shown left) to accommodate the FTIR system components (shown right) and allow easy access to the internal region of the STS chamber.

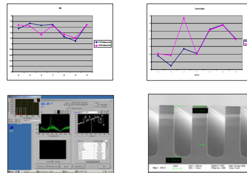
FTIR SYSTEM SCHEMATIC



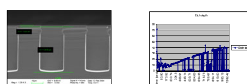
Basic system schematic with actual screen shot of the software (shown lower right). The IR spot is first positioned on the appropriate features to be measured, then the DRIE process is started. The "fit" of the algorithm is frequency based, which allows it to be fast enough to keep up with the constantly changing etch profile

RESULTS

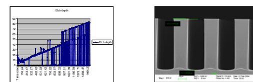
SUBSTRATE: Silicon / resist pattern
FEATURES: 20 micron lines and spaces



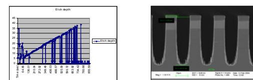
SUBSTRATE: Silicon / resist pattern
FEATURES: 20 micron square hole array



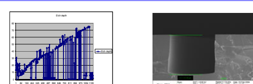
SUBSTRATE: Silicon / resist pattern
FEATURES: 20 micron square pillar array



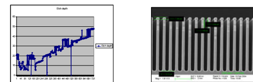
SUBSTRATE: Silicon / resist pattern
FEATURES: 10 micron wide trench



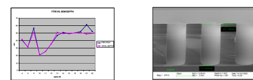
SUBSTRATE: Silicon / resist pattern
FEATURES: 100 micron wide trench



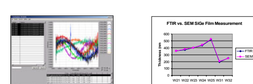
SUBSTRATE: Silicon / resist pattern
FEATURES: 2 micron lines and spaces



SUBSTRATE: SOI / resist pattern
FEATURES: 20 micron lines and spaces



SUBSTRATE: undoped SiGe on silicon
FEATURES: blanket film measurement



CONCLUSION

The results of the FTIR system *in-situ* depth measurement system for DRIE processing are shown to the left. The unique system has demonstrated a remarkable and repeatable capability of perfoming accurate depth measurements for a wide range of different features on silicon.Importantly, the SOI etch processes of FTIR vs. SEM measurement results were impressively similar. Furthermore, it has been shown that the tool can measure undoped silicon germanium film thicknesses as well. Not surprisingly, larger sized features allow for a deeper monitor of the etch due to signal strength, but it has been shown that 2 micron lines and spaces could be measured accurately down to ~35 microns. The system will undoubtedly serve as a practical means to measure *in situ* etch depth for deep silicon etching

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