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KrF EXCIMER LASER MICROMACHINING OF SILICON FOR MICRO-CANTILEVER

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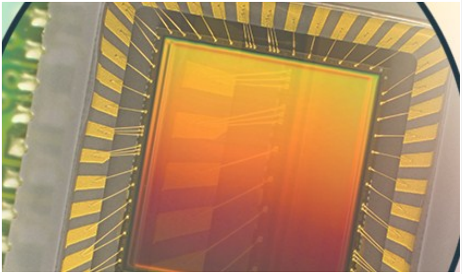

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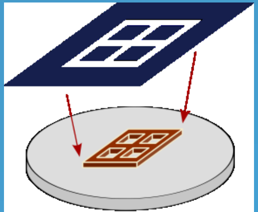
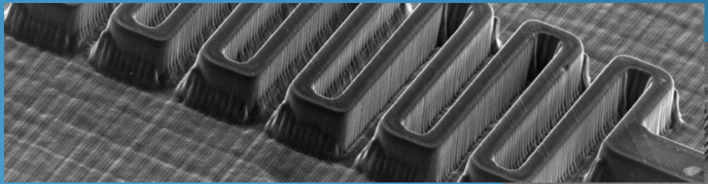
PRESENTATION OUTLINE

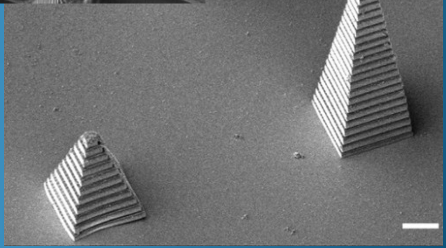
- Research Background
- Excimer Laser Micromachine
- Micromachine System
- Microcantilever Formation
- Conclusion

RESEARCH BACKGROUND

The conventional photolithography of crystalline silicon techniques is limited to two-dimensional and structure scaling. This can be overcome by using laser micromachine, a technique capable of producing three-dimensional structure and simultaneously avoiding the needs for photomasks. RapidX-250 excimer laser micromachine with 248 nm of KrF is used in this research to create in-time mask design and assisting the fabrication of micro-cantilever structures.



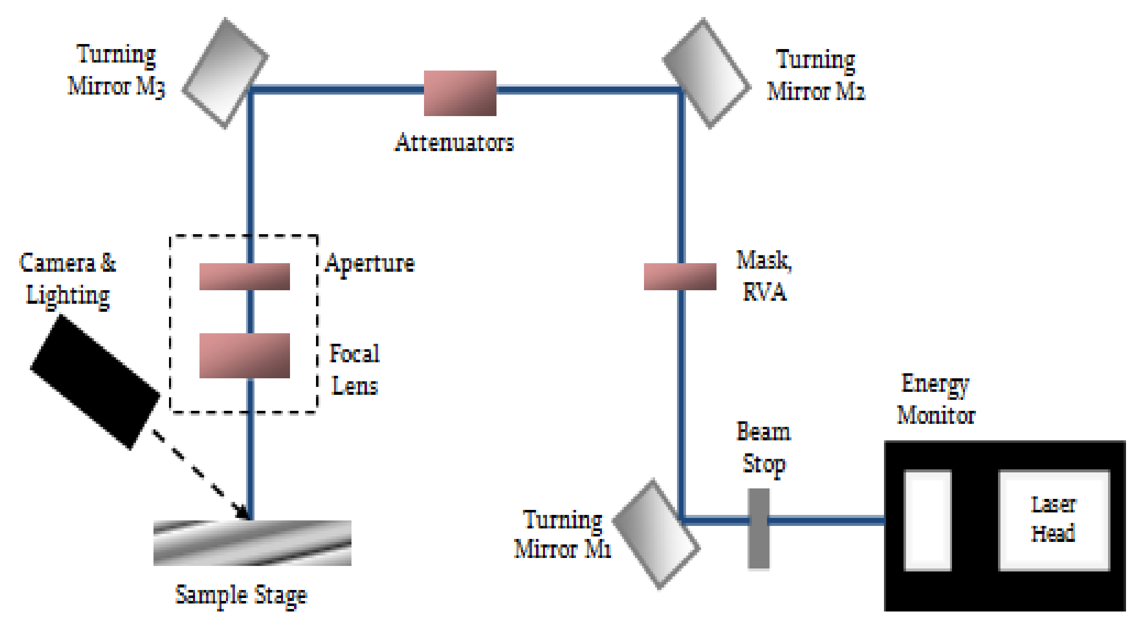




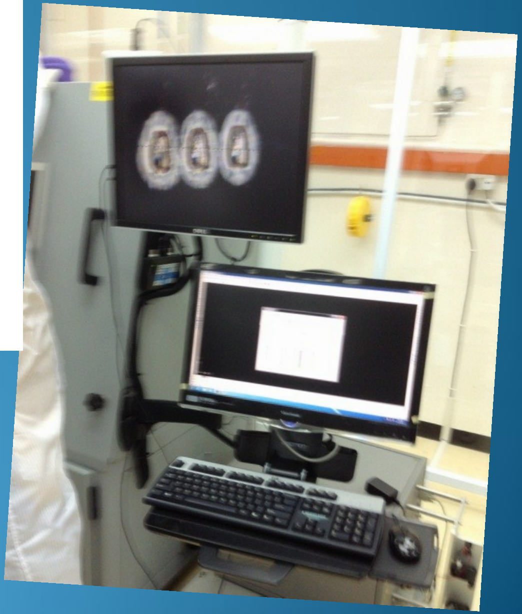
EXCIMER LASER MICROMACHINE

The 248nm of wavelength is a deep laser which is commonly used in semiconductor industrial manufacturing. The most important aspects provided by laser pulsed micromachining includes good quality in high resolution, high precision, high process speeds, low thermal damage and applicable to many materials. Besides, it also needs few processing steps, highly flexible Computer Numerical Control (CNC) programming depending on prototyping shapes, no larger cleanroom facilities and less hazardous to human substances.

MICROMACHINE SYSTEM



RapidX-250 laser beam circulation and Internal hardware system.



MICROCANTILEVER FORMATION

Laser Energy (mJ)

The main parameter investigated in this research is laser energy (mJ) which is laser beam energy level that are supplied to form laser beam.

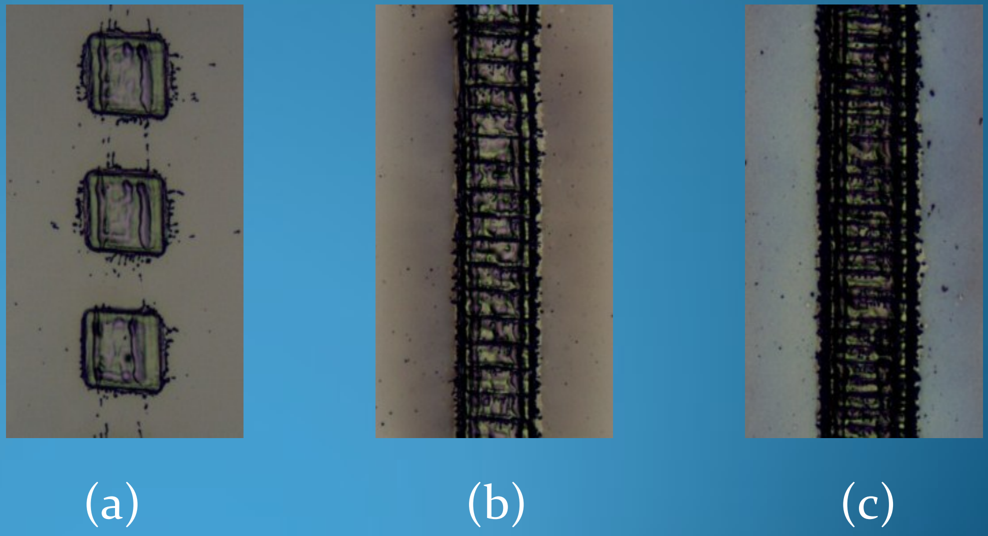
(a) (b) (c)

Surface morphology with difference energy level;
(a) 12mJ, (b) 15mJ, (c) 18mJ.

MICROCANTILEVER FORMATION

Number of Pulses

The number of laser pulses in second is a part of important criteria for excimer laser experiment. The maximum number of laser pulses provide by the RapidX-250 laser micromachine is 300 pulses. The number of pulses will be determining the laser line pattern either in gross or smooth line.

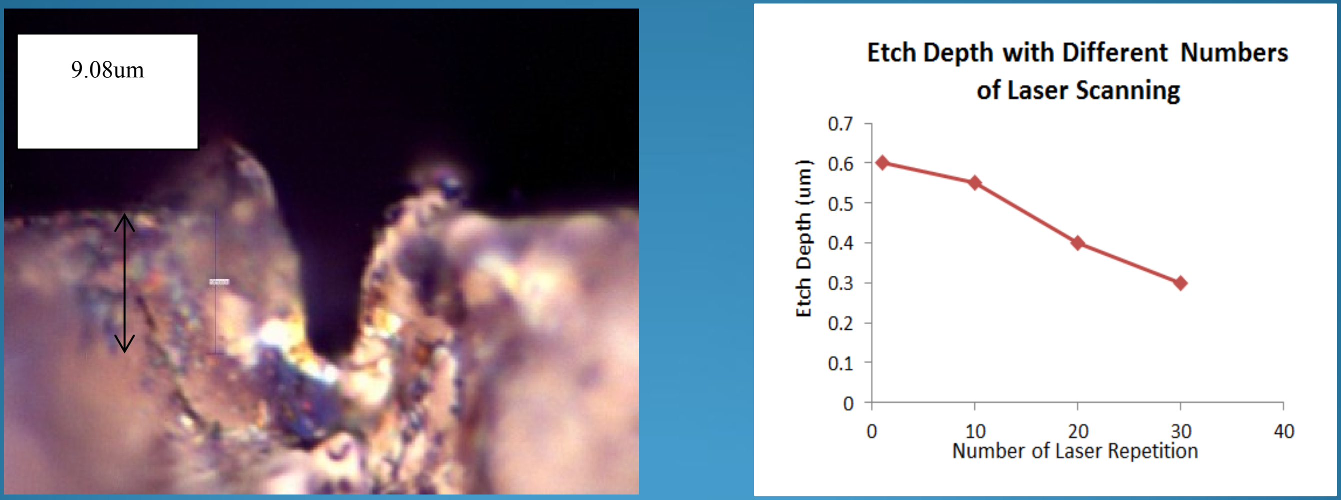


Differences in pulse number;
(a) 10 pulses, **(b)** 50 pulses,
(c) 100 pulses

MICROCANTILEVER FORMATION

Etch Depth

Etch rate in µm/shot is defined as average etched depth by each laser shot.



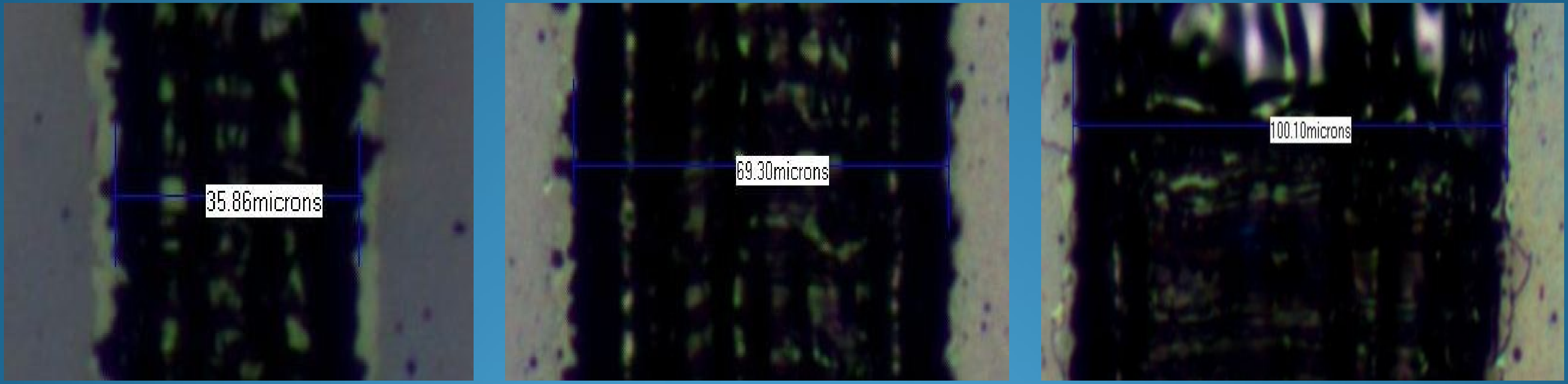
(a) (b)

Etch rate characteristics; **(a)** Etch depth for 30 times lasers scanning, **(b)** Relations between number of laser scanning and etch depth.

MICROCANTILEVER FORMATION

Rectangular Variable Aperture (RVA)

The other parameter required in this research is the laser beam size aspect ratio which is defines as RVA in milimeters unit.



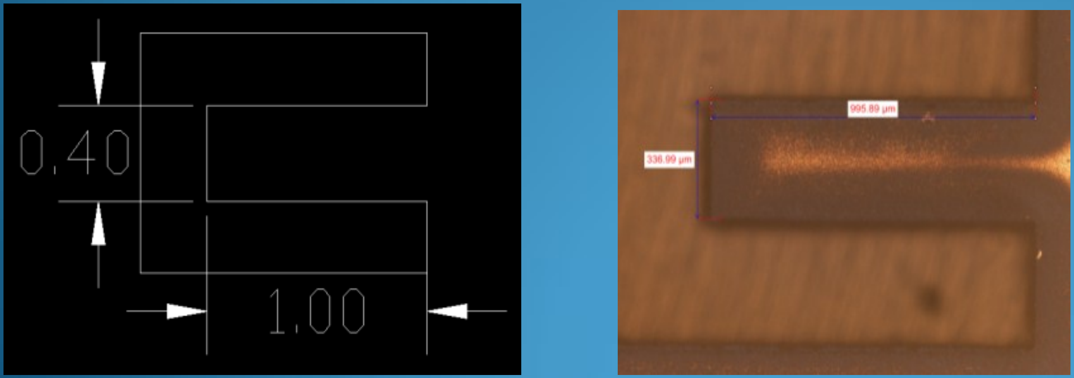
(a) (b) (c)

Laser ablation by differences RVA; **(a)** 0.5mm of RVA, **(b)** 1.0mm of RVA, **(c)** 2.0mm of RVA.

MICROCANTILEVER FORMATION

Silicon Microcantilever

Scanning pulse at 250 pulses, 15mJ of laser energy and 0.5mm RVA were programmed to obtain a high quality of microcantilever structure. Cantilever dimension was designed in AutoCAD with 1.0mm x 0.4mm. In figure below, microcantilever structure has been produced by 290 times of laser beam scanning. The experimental result shows the dimension of microcantilever of 990um x 350um for the length and width respectively. It is demonstrated that the features of pulse etching depth can be defined as 0.5um per scan for silicon substrate.

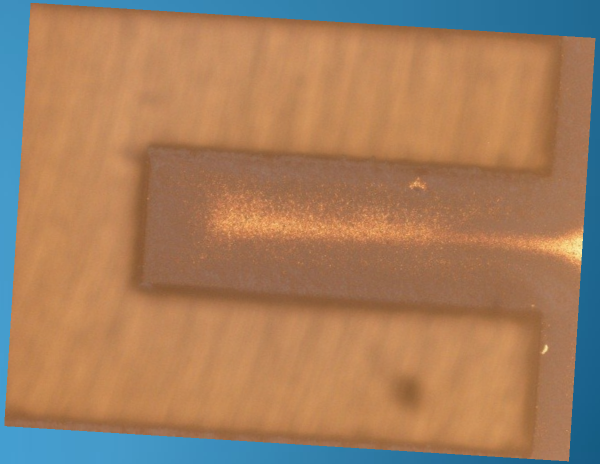


(a) (b)

Microcantilever formation by excimer laser micromachine;
(a) Mask design in millimeter,
(b) Microcantilever top view.

CONCLUSION

Silicon thickness of 160um was prepared for microcantilever formation and the optimum parameter is programmed in the computerize operations process. The maximum laser energy will affect the edge roughness and heat radiation on the side of the line. This is probably related to the presence of thermal radiation and laser beam aperture in the laser formation process. The laser repeatable and beam aperture also affected the roughness of the microcantilever structure. The desired structure can be reached with 15mJ, 250 pulses, 0.5mm of the power, scanning laser and RVA respectively. Physical characteristic by HPM reveals that laser ablation with these parameters can produce the optimum cantilever structure.



THANK YOU

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