Tool for automating the process of nanofabrication using focused-ion beam

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Abstract

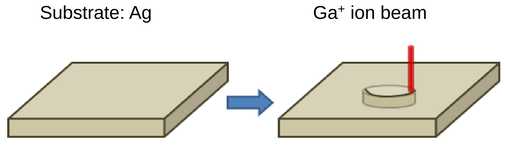
Problem:
Automate the process of nanofabrication using focused ion beam (FIB).

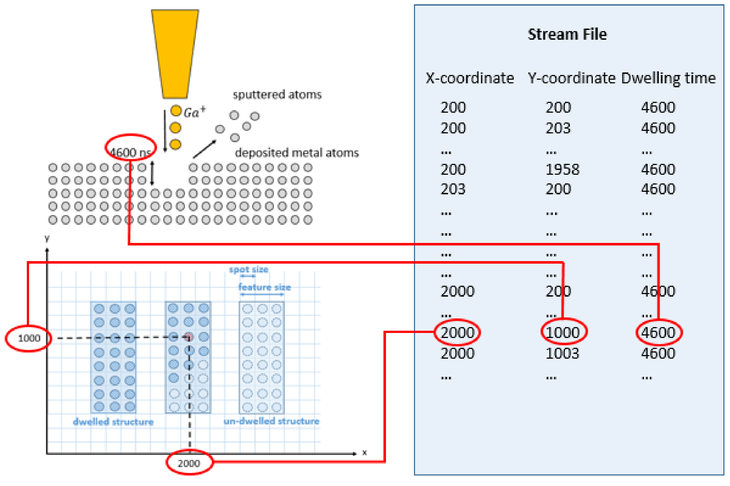
Scope of work:
Develop a MATLAB based tool that automatically generates the stream file, which can be directly interpreted by the focused ion beam software to produce a 3D structure with great geometric flexibility.

Results:
Generate stream files for arrays of circular nanoholes and sets of slot or v-groove shaped trenches. An intuitive GUI for the tool has been developed.

Introduction

Principle of focused ion beam milling [1, 2]





Stream File

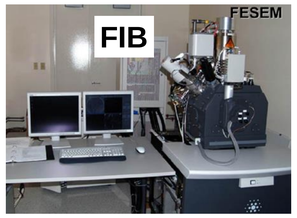
X-coordinate	Y-coordinate	Dwelling time
200	200	4600
200	203	4600
...	...	...
200	1958	4600
203	200	4600
...	...	...
...	...	...
...	...	...
...	...	...
2000	200	4600
...	...	...
2000	1000	4600
2000	1003	4600
...	...	...

Methods

Tool design
We used MATLAB to create the tool and its GUI so that the stream files for various nanostructures can be generated automatically.

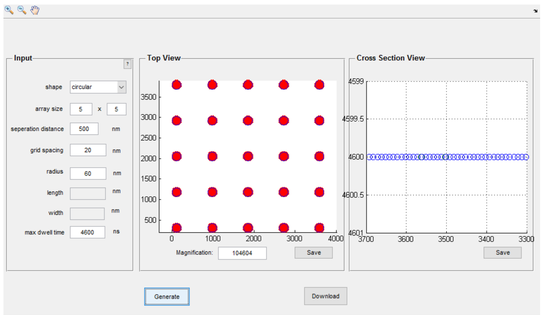
Nanostructure fabrication
We grew 200-400 nm silver films on MgO substrate[3]. We uploaded the resulting stream files to the control software of the focused ion beam setup (FEI Nova 200). We used the FIB to fabricate the nanostructure array in silver by focused-ion beam.

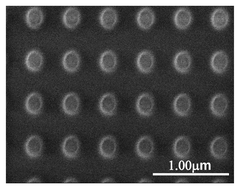
Results analyzation
We analyzed the quality of the nanostructures the by scanning electron microscopy (SEM).



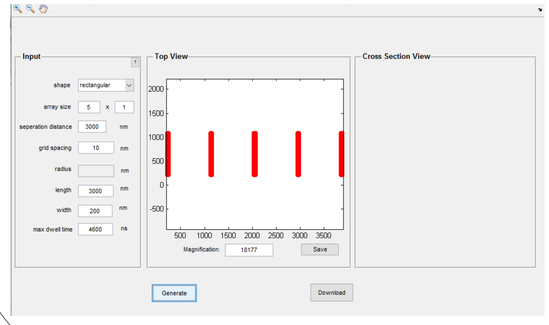
Results

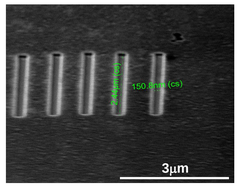
Circular nanostructure array



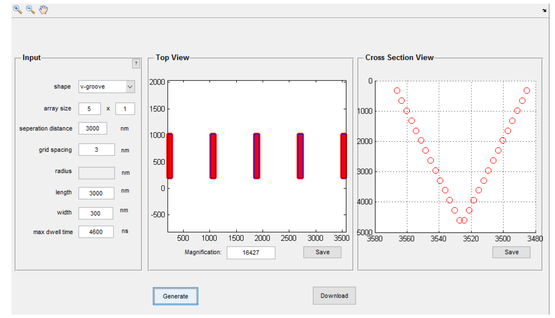


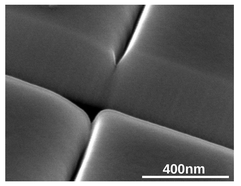
Rectangular nanostructure array





V-groove nanostructure array





Conclusion

Conclusion
- For a 50X50 nanohole array, it takes 90 secs to generate the stream file and 10 mins to mill the nanostructure, which saves ~3hrs.
- The v-groove nanostructure array can be also successfully fabricated by the tool, which was not possible without it.

Future plan
- To expand the tool capabilities for other shapes of nanostructures.
- Turn the MATLAB tool into an online application available on nanohub.org.

References

[1] S. Reyntjens, R. Puers, J.Micromech. Microeng. 11, 287-300(2001)
[2] A. A. Tseng, Small, 1 (10), 924-939 (2005)
[3] A. M. Flank, et al, Phys. Rev. B, 53, R1737(R) (1995)

Acknowledgement

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