Laser-assisted micro/nanoscale material processing and in-situ diagnostics

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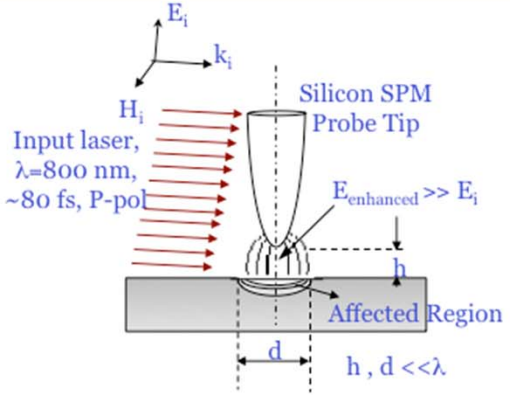
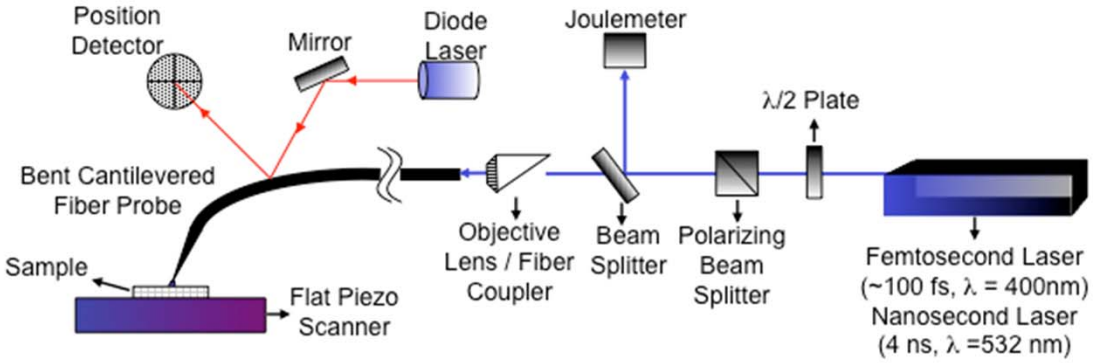
Introduction to optical near-field

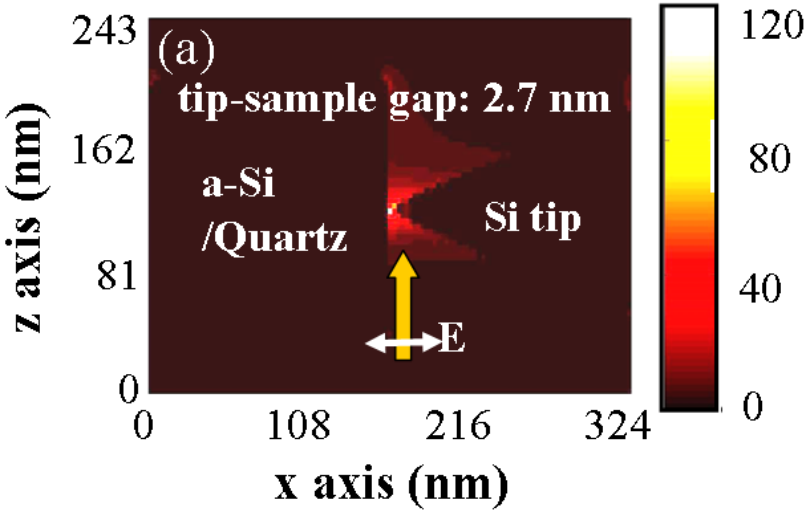
Coupling of laser (light) illumination onto the sharp tip structures for sub-diffraction limit confinement

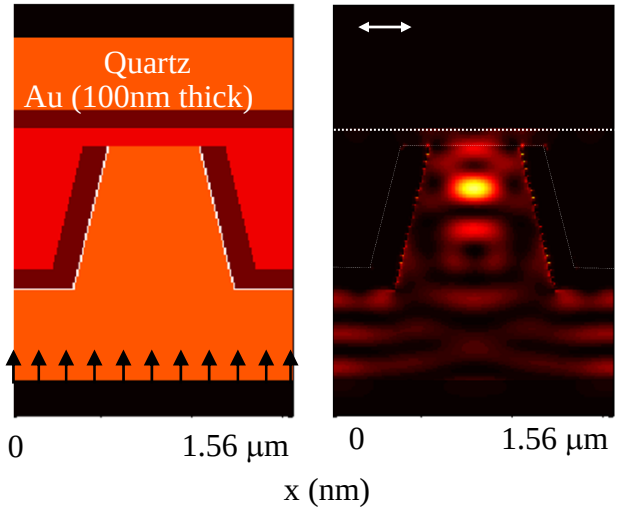
Apertureless NSOM



Apertured Fiber Coupled NSOM





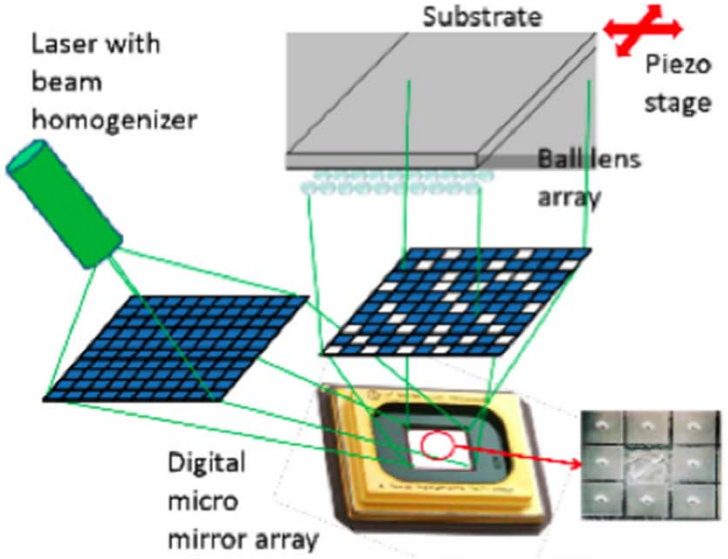


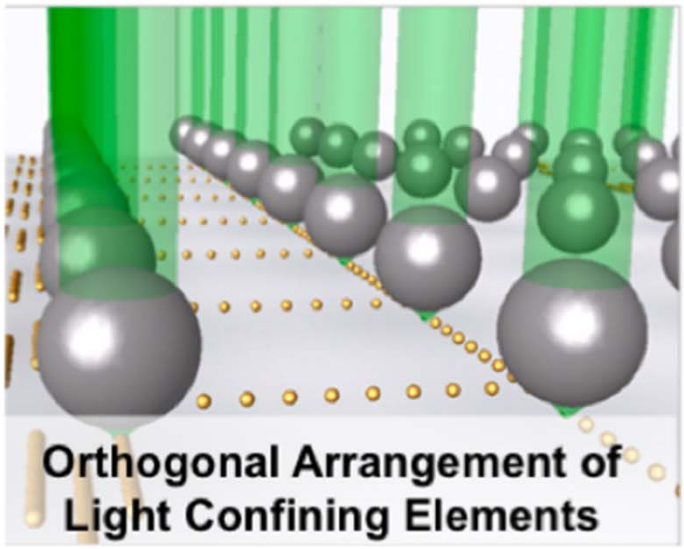
D.J. Hwang, S.G. Ryu, N. Misra, H.J. Jeon, and C.P. Grigoropoulos, Applied Physics A (2009).
A.Chimmalgi, C. P. Grigoropoulos, and K. Komvopoulos, J. Appl. Phys. 97, 104319 (2005).
A. Chimmalgi, Choi, T.–Y., Grigoropoulos, C.P., and Komvopoulos, K., 2003, Applied Physics Letters, Vol. 82, pp. 1146–1148.
D.J. Hwang, Chimmalgi A., Grigoropoulos C. P., J. Appl. Phys. 99(4), 044905, 2006.
C.P. Grigoropoulos, and D.J. Hwang, in *Nanomanufacturing* (Chapter 9), ed. by Chen, American Scientific Publishers, In-press, 2009.
C.P. Grigoropoulos, A. Chimmalgi, D.J. Hwang, in *Laser ablation and its applications* (Chapter 19), Springer Series in optical sciences, New York, 2007.
C.P. Grigoropoulos, D.J. Hwang, A. Chimmalgi, MRS Bulletin (32) January Issue. (2007).

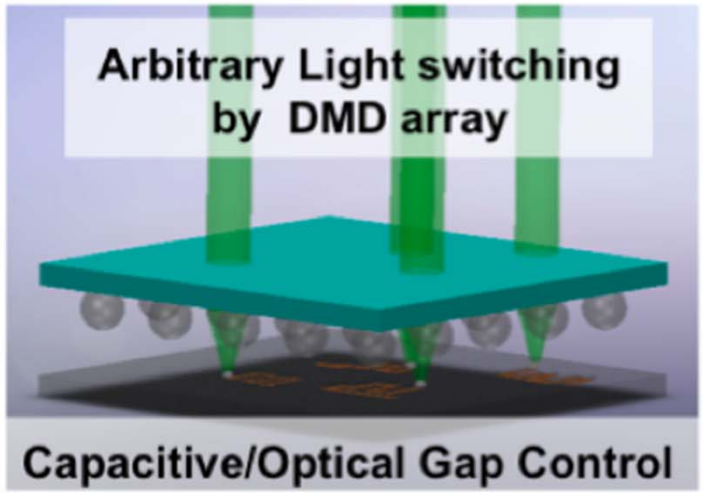
Scalable Nanomanufacturing by Optical Near-Field

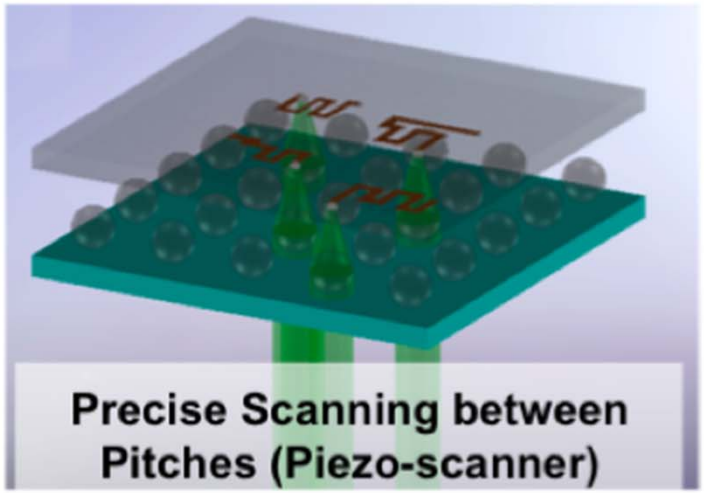
Collaboration with Prof. Bauerle, Univ. of Linz, Austria

Use of Microsphere Array as Array of NSOM Probe







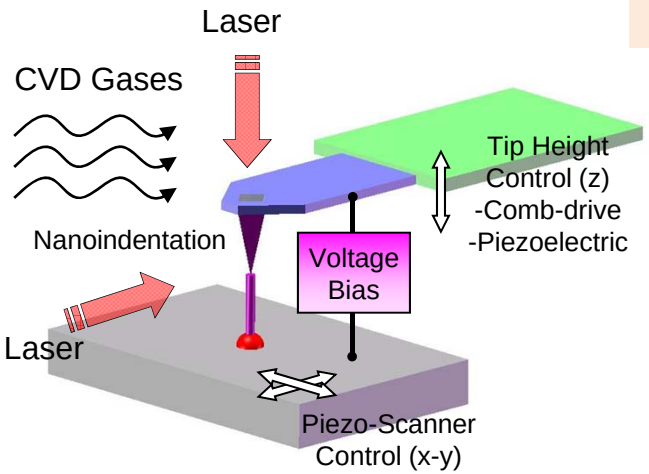


- H. Pan, D.J. Hwang, C.P. Grigoropoulos et. al., Small, 2010
- D.J. Hwang and C.P. Grigoropoulos, "Arbitrary pattern direct nanostructure fabrication methods and system," US20110318695 A1 (2011)

Laser Based Scalable Nanowire Growth

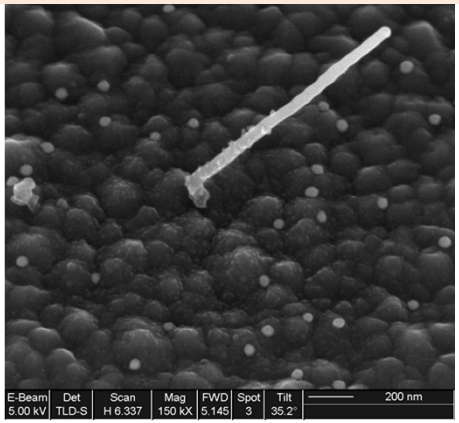
Nanofabrication by Tips coupled with Lasers

(Main PI: Prof. Grigoropoulos, UC Berkeley), Funded by Darpa, MTO

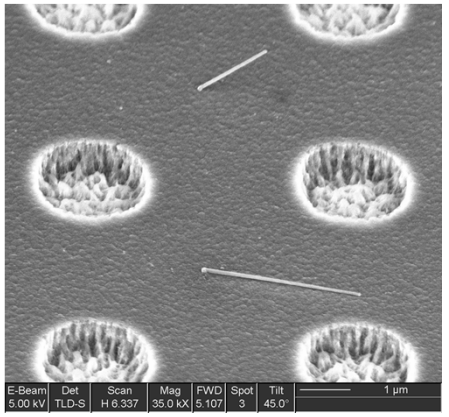


Processing Scheme

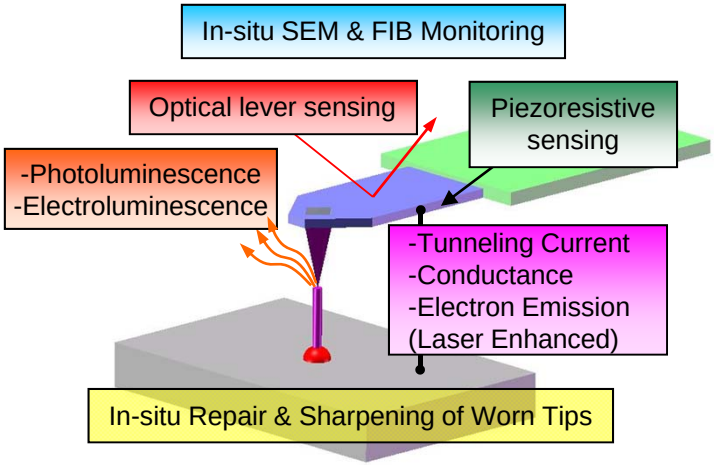
Demonstrated Localized Si & Ge Nanowire Synthesis



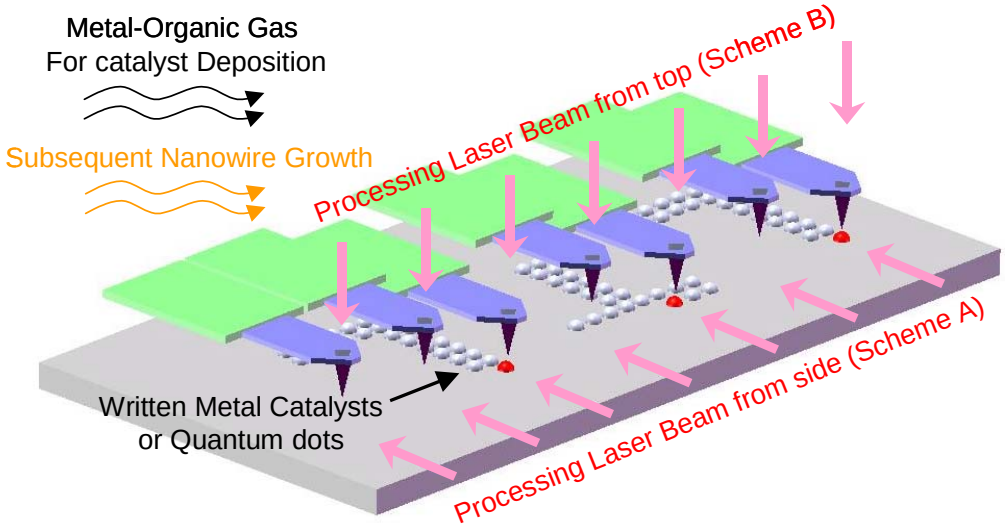
Single catalyst Selectivity



Heterogeneous growth

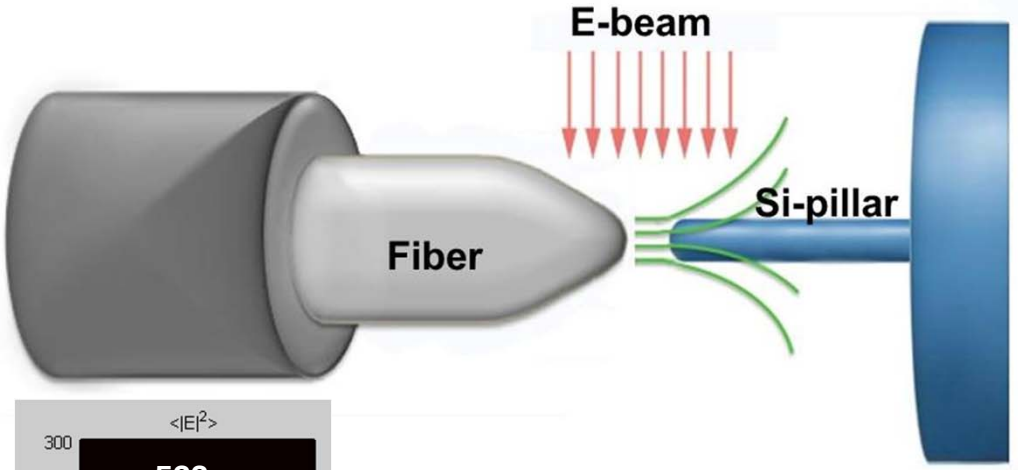


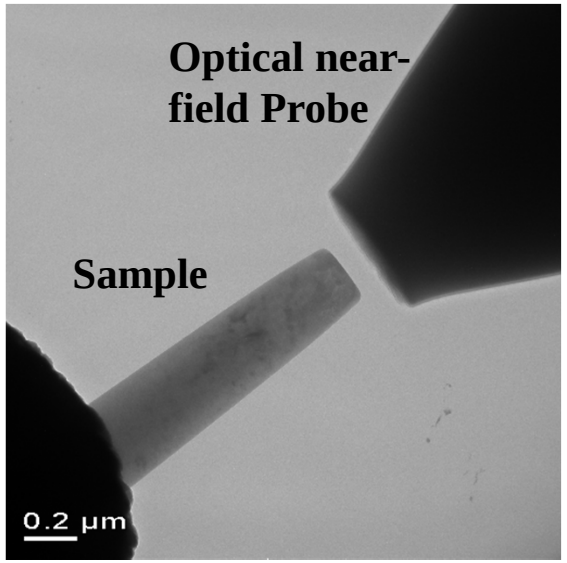
In-situ Monitoring Scheme

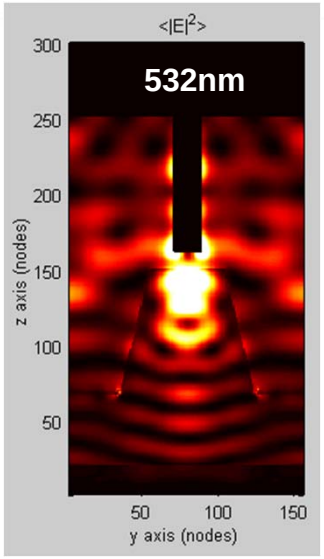


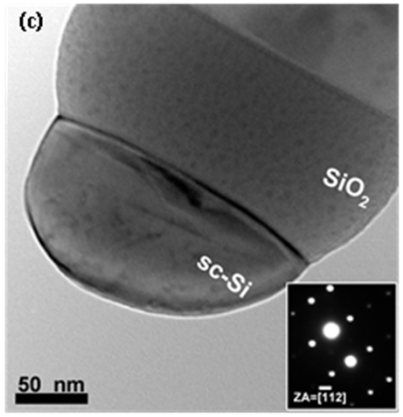
Parallel Processing Overall Configuration

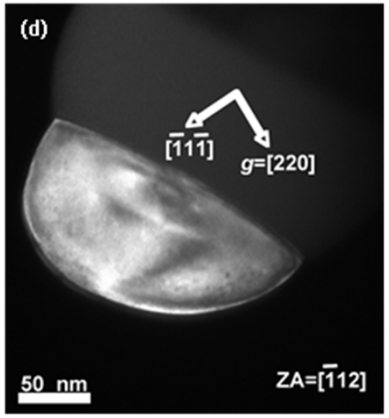
In-situ monitoring of laser processing in TEM

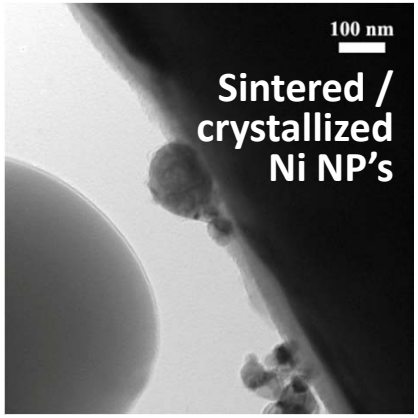












Optical near-field simulation

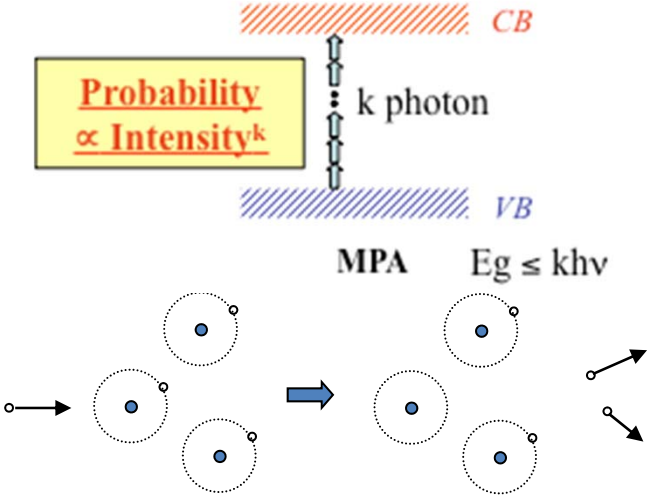
Achievement of Single Crystal Si by in-situ laser crystallization in TEM

In-situ laser sintering process

B. Xiang, D. J. Hwang, J. B. In, S.-G. Ryu, J.-H. Yoo, O. Dubon, A. M. Minor, and C. P. Grigoropoulos, "In Situ TEM Near-Field Optical Probing of Nanoscale Silicon Crystallization," Nano Letters, vol. 12, pp. 2524-2529 (2012).

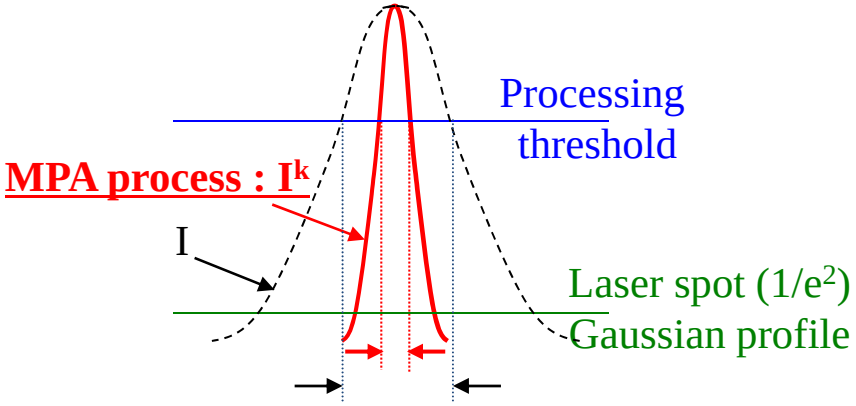
Sub-diffraction limit feature by optical far-field

Multi-Photon Absorption Process



Electron avalanche

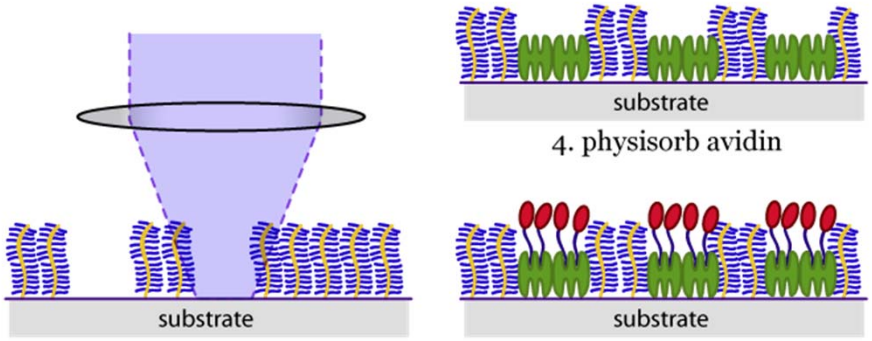
Sub-diffraction limit Feature size

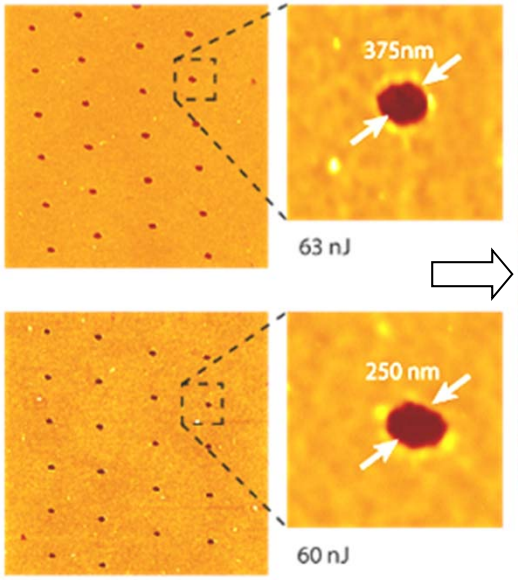


→ Sub-diffraction limit sized features

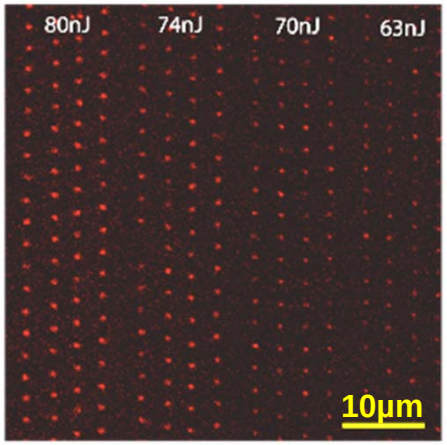
Selective protein adhesion spot by fs laser

peg (cell protecting) film on glass wafer (cell adhesive)





AFM images after laser process step



Confocal microscope images of adsorbed protein

H.J. Jeon, R. Schmidt, J.E. Barton, D.J. Hwang, L.J. Gamble, D.J. Castner, C.P. Grigoropoulos, and K.E. Healy, JACS 133(16), 6138 (2011)