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Supporting Information

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Fluorocarbon resist for high speed scanning probe lithography

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Tapping Mode Patterning

Patterning experiments were also performed in tapping mode[TM] with boron doped silicon cantilevers Veecoprobes (_ = 1-10 Ohm-cm, k= 40 N/m, _=300 kHz).

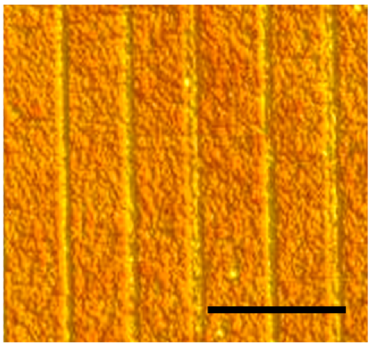

Figure S1. Tapping mode AFM image of lines written in tapping mode with +6V bias on sample and tip speed= 600 _m/s. Scale bar 1 _m

Using optimal patterning conditions, we were capable of writing 60 nm wide 0.4 nm tall lines (Figure S1) at a tip speed of 600 _m/s. Patterning at higher velocities to reduce feature size resulted in severely defective lithography due the slow response of the feedback loop. Contact mode patterning using softer cantilevers compensate for the delay in the piezo vertical displacement without significant tip damage and reliable writing of smaller features at 1 cm/s tip velocity was achieved.

Line width estimate for lines written in contact mode

Line width of the patterns written in contact mode (Figure 1c, MS) was estimated by first taking a cross section of the line profile in the positions indicated by the colored segments (Figure S2a) and plotting the height of the lines as a function of the relative horizontal displacement (Figure S2b). The resulting plot for each line was then fitted using the Gaussian function $h = h_0 e^{-(x-x_0)^2/2\sigma^2}$, where h_0 is the peak height and x_0 is the peak relative position. This was used to estimate the full width half maximum of the line from the parameter _ as FWHM= 2.35 _. The FWHM is used as an estimate of the line width. The error in the measurement is estimated from error dispersion of the uncertainty in the fitting parameter.

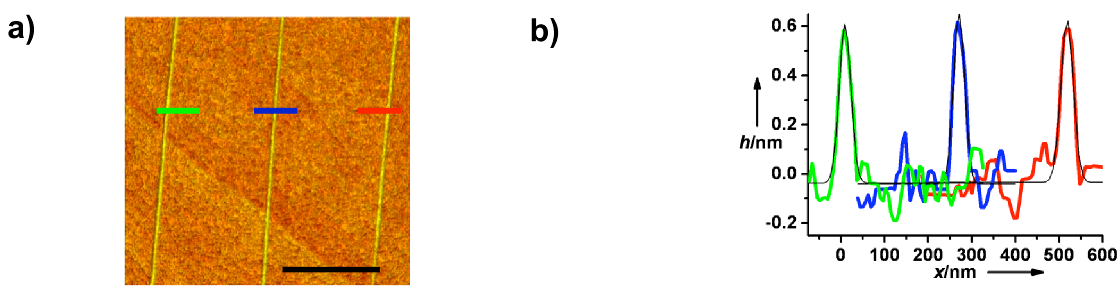

Figure S2. a) Tapping mode AFM image of lines patterned in contact mode with colored bars indicating the positions of the height profiles. B) Height profiles (color coded) of the patterned lines and fitted Gaussian peaks (black trace) used to estimate the line width.

Pattern design for optimal high speed lithography

In order to achieve the pattern fidelity, shown in figure 3 MS we have designed a layout that moved the sample in a continuous zigzag fashion (Figure S3). This allows compensating for piezo drift in our system not equipped with a close loop scanner and minimizes the effects of torsional bending of the cantilever.

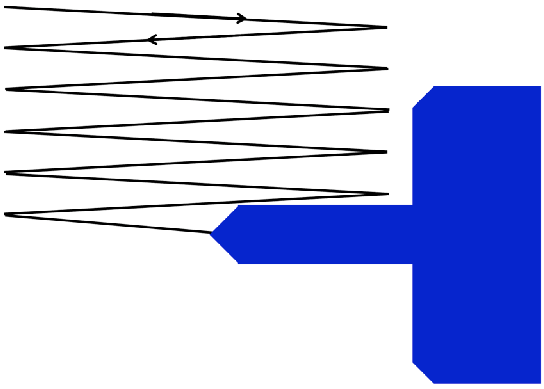

Figure S3. Schematic representation of patterning layout and translation of the AFM tip relative to the sample.

PEEM data at fluorine edge

PEEM data was acquired on patches made with SPL in PF8 at the fluorine edge (Figure S4).

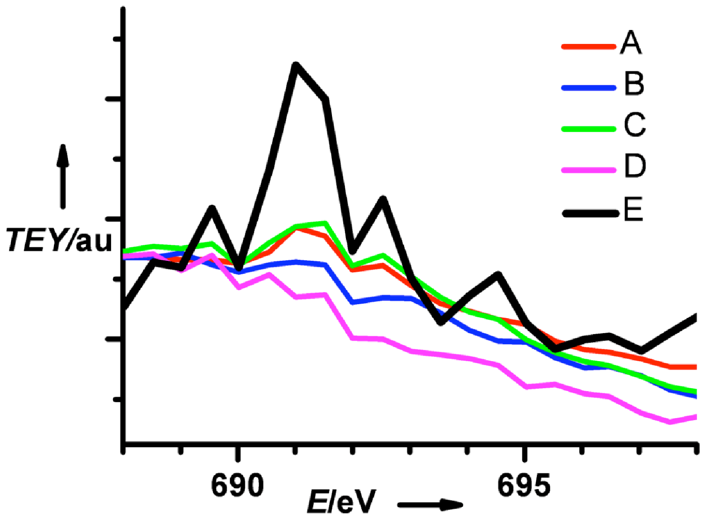

Figure S4. PEEM spectra acquired at the Fluorine edge. Coloured spectra rapresent the raw data. A and C on patterns, B and D away from patters. Spectrum E= (A+C)/ (B+D).

Data acquired at the fluorine band edge confirms the presence of Fluorine in the patterns; the peak at 692 eV in figure 4 is associated with the presence of F bound to C.[1] This data supports the conjecture proposed from analysis of the C K-edge data and is supported by the results of SIMS analysis.

References

[1] E. E. Johnston, B. D. Ratner, *J. Electron. Spectrosc.* **1996**, *81*, 303-317.