

ARTICLE – Supplementary Information

Optimizing Microfluidic Flow Cell Geometry for In-Situ Resonant Soft X-ray Characterization of Molecular Nanostructures

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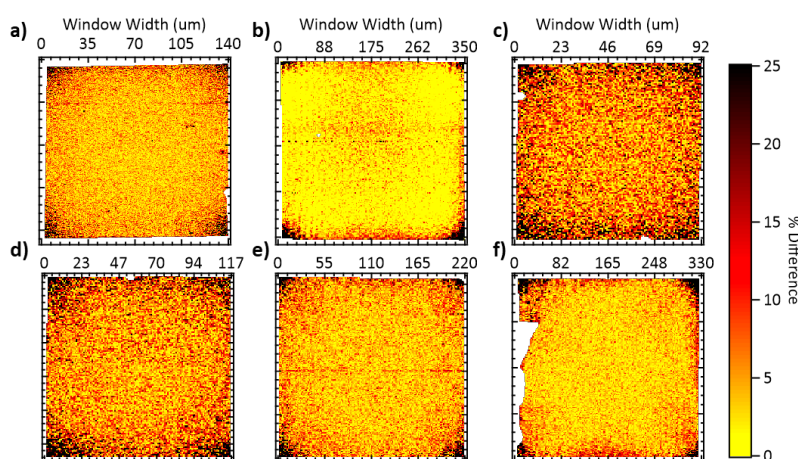


Figure S1. Spatial maps of the percent difference between experimental and modeled deformation for all six window sizes measured, using KLPT as the model. a) and b) are 50 nm thick SiN and c) through f) are 100 nm thick SiN. a) 135 μm x 139 μm . b) 344 μm x 340 μm . c) 89 x 94. d) 113 μm x 124 μm . e) 217 μm x 226 μm . f) 317 μm x 318 μm .

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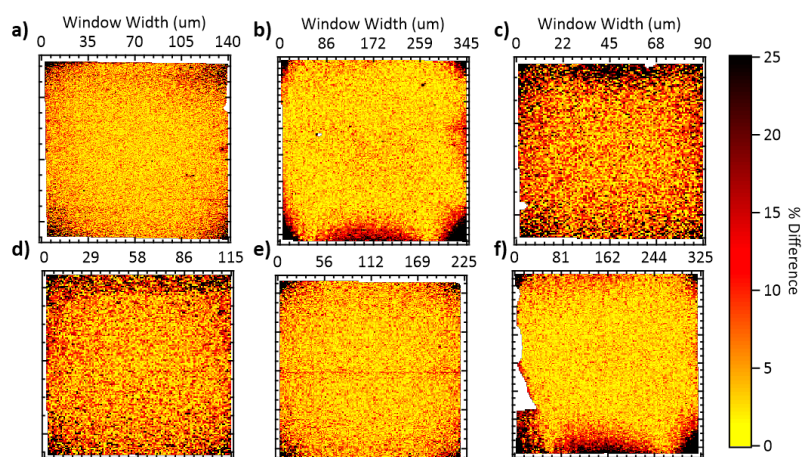


Figure S2. Spatial maps of the percent difference between experimental and modeled deformation for all six window sizes measured, using crossed parabolas as the model. a) and b) are 50 nm thick SiN and c) through f) are 100 nm thick SiN. a) $138\mu\text{m} \times 143\mu\text{m}$. b) $344\mu\text{m} \times 340\mu\text{m}$. c) 91×95 . d) $114\mu\text{m} \times 124\mu\text{m}$. e) $217\mu\text{m} \times 226\mu\text{m}$. f) $320\mu\text{m} \times 318\mu\text{m}$.

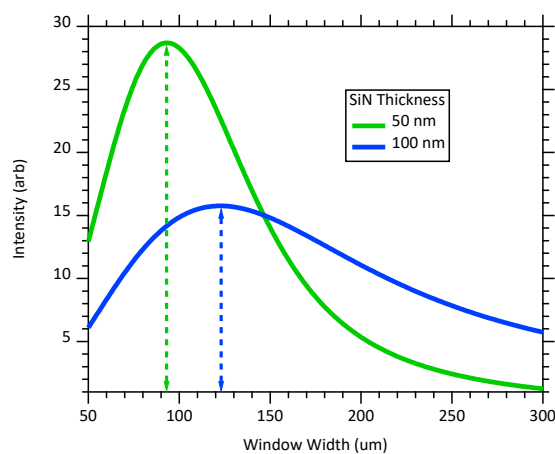


Figure S3. Intensity versus window size at 285 eV for optimal PS concentration of 2.5% for SiN thickness of 50 nm (Green) and 100 nm (Blue).

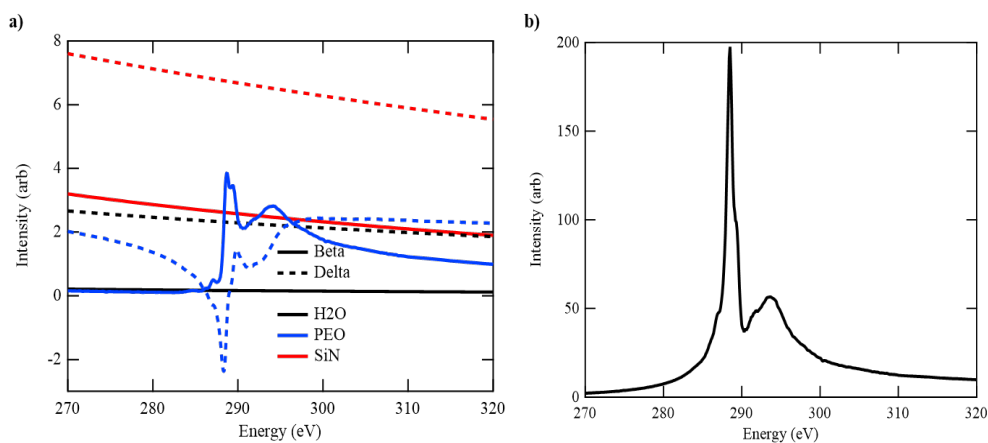


Figure S4. a) Optical constants Delta and Beta as a function of energy for H₂O (Black), PEO (Blue), and SiN (Red). b) Contrast function between PEO and H₂O using the optical constants from Figure S4a.

Deformation Model

Table S1. Fit coefficients for the quadratic fit lines found in Figure 2.

SiN Thickness	a	bx	cx^2
50 nm	0 ± 0	$9.2\text{e-}02 \pm 7.2\text{e-}04$	$5.9\text{e-}05 \pm 3.6\text{e-}06$
100 nm	0 ± 0	$7.1\text{e-}02 \pm 4.3\text{e-}04$	$4.9\text{e-}05 \pm 1.9\text{e-}06$

Equation S1 and S2 are the generalized and individual forms of ω used in the calculation of the deformation model. The additional term inside the sine function of **Equation S2**, $(a - b)/2$, puts the apertured window in quadrant 1 of the xy-plane with the corner at the origin. By swapping x and y in **Equation S2** the window is rotated by π to simulate the upper and lower window orthogonal overlapped.

$$\omega(x, y) = \frac{16P}{D\pi^6} \sum_{m=1,3,5,\dots}^{\infty} \sum_{n=1,3,5,\dots}^{\infty} \frac{\sin\left(\frac{m\pi x}{a}\right) \sin\left(\frac{n\pi y}{b}\right)}{mn\xi_{mn}^2} \quad (\text{S1})$$

$$\omega_1(x, y) = \frac{16P}{D\pi^6} \sum_{m=1,3,5,\dots}^{\infty} \sum_{n=1,3,5,\dots}^{\infty} \frac{\sin\left(\frac{m\pi}{a}x\right) \sin\left(\frac{n\pi}{b}\left(y - \frac{a-b}{2}\right)\right)}{mn\xi_{mn}^2} \quad (\text{S2})$$

$$\xi_{mn} = \left(\frac{m^2}{a^2} + \frac{n^2}{b^2}\right) ; \quad D = \frac{H^3 Y}{12(1 - \nu^2)}$$

ω is the position-dependent distance of deflection of the plate (window) in the z-direction, P is the uniform applied load (pressure), H is the thickness of the window, Y is Young's modulus, and ν is the Poisson's ratio. Where the values of Y and ν used are 258 kPa and 0.23 respectively.¹

Equation S3 is the full form of the formula for calculating the total transmitted intensity.

$$I_{meas} = \frac{4\pi^2 \bar{B} (dx dy)^2 E^4}{h^4 c^4} \Delta \tilde{n}_{12}^2 \phi_1 \phi_2 \gamma \exp \left[-\frac{(x - x_0)^2}{\sigma_x^2} - \frac{(y - y_0)^2}{\sigma_y^2} - 2\mu_{SiN} t_{SiN} - \frac{4\pi \bar{B}}{\lambda} \sum_i c_i \beta_i \right] \quad (\text{S3})$$

References

- 1 Y. Hwangbo, J.-M. Park, W. L. Brown, J.-H. Goo, H.-J. Lee and S. Hyun, *Microelectron. Eng.*, 2012, **95**, 34–41.