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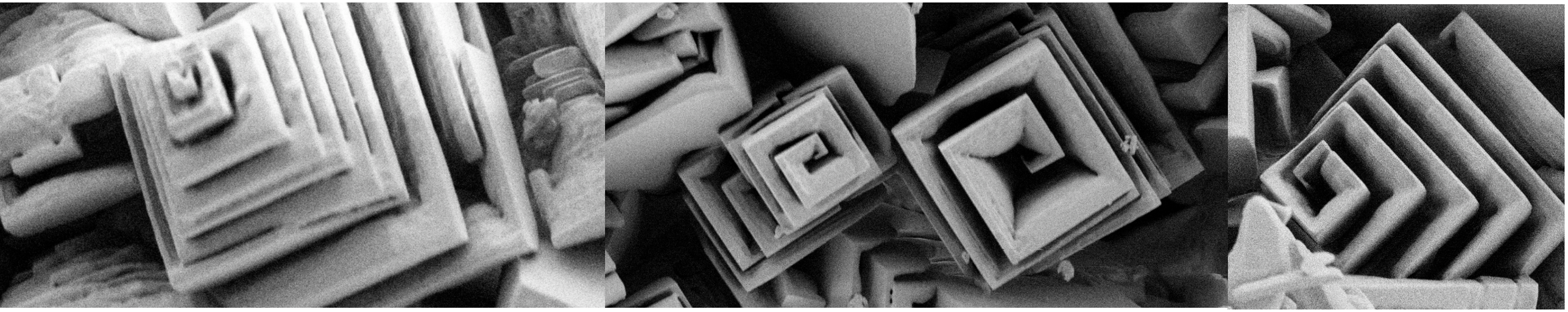
Microenergetics: Characterization of sub-millimeter PETN films.

Ryan R. Wixom, Alexander S. Tappan, Gregory T. Long, Anita M. Renlund, Eric J. Welle, Joel P. Mcdonald, Bradley H. Jared, Aaron L. Brundage, and Joseph R. Michael.



Sandia National Laboratories

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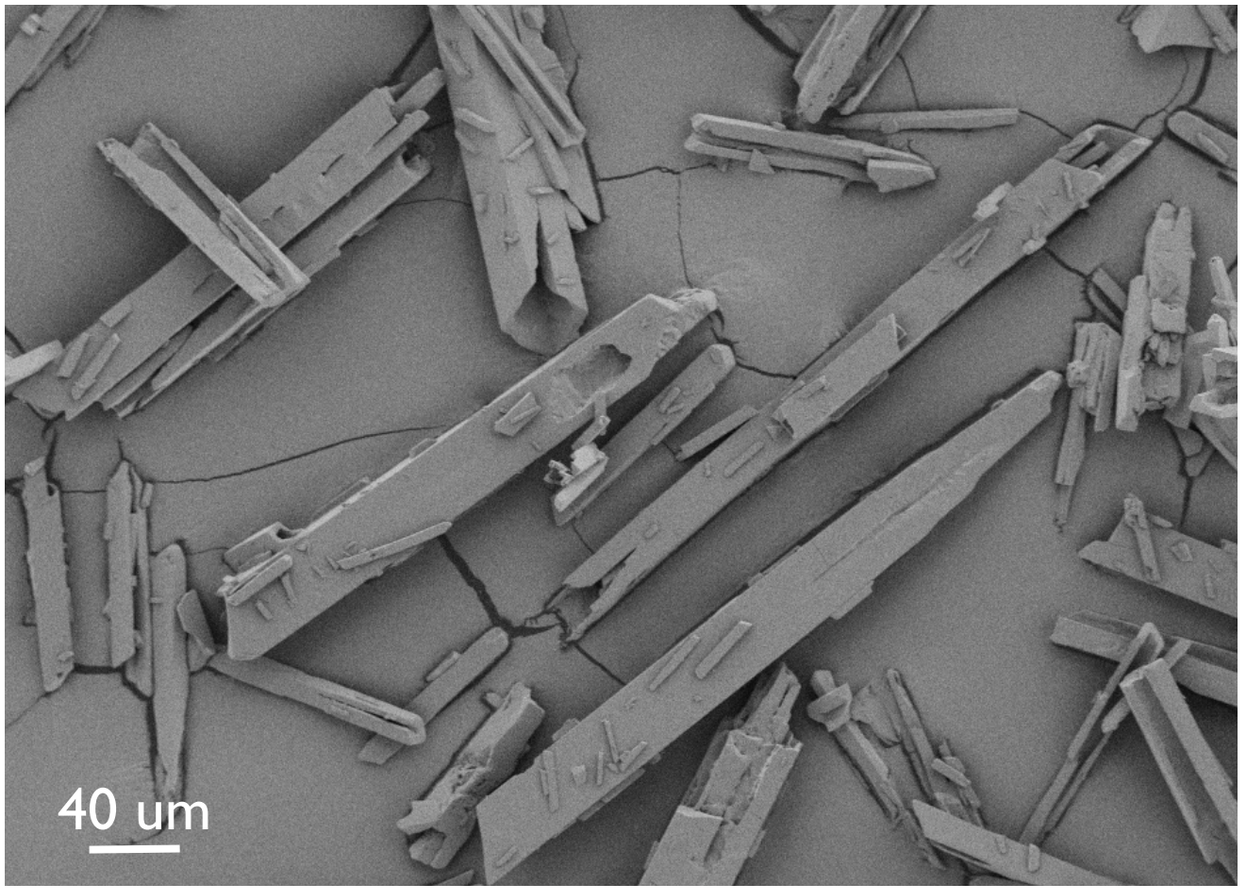
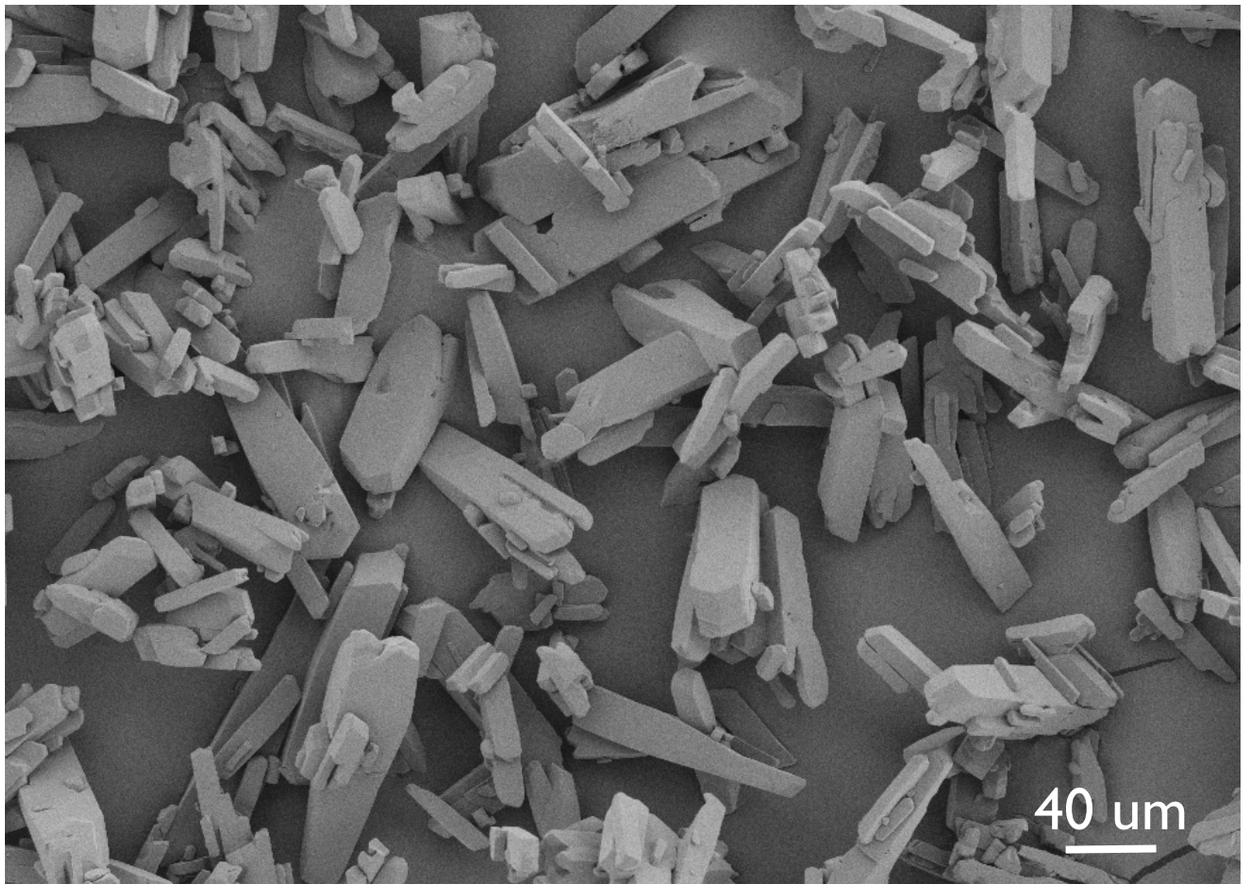
01: OUTLINE

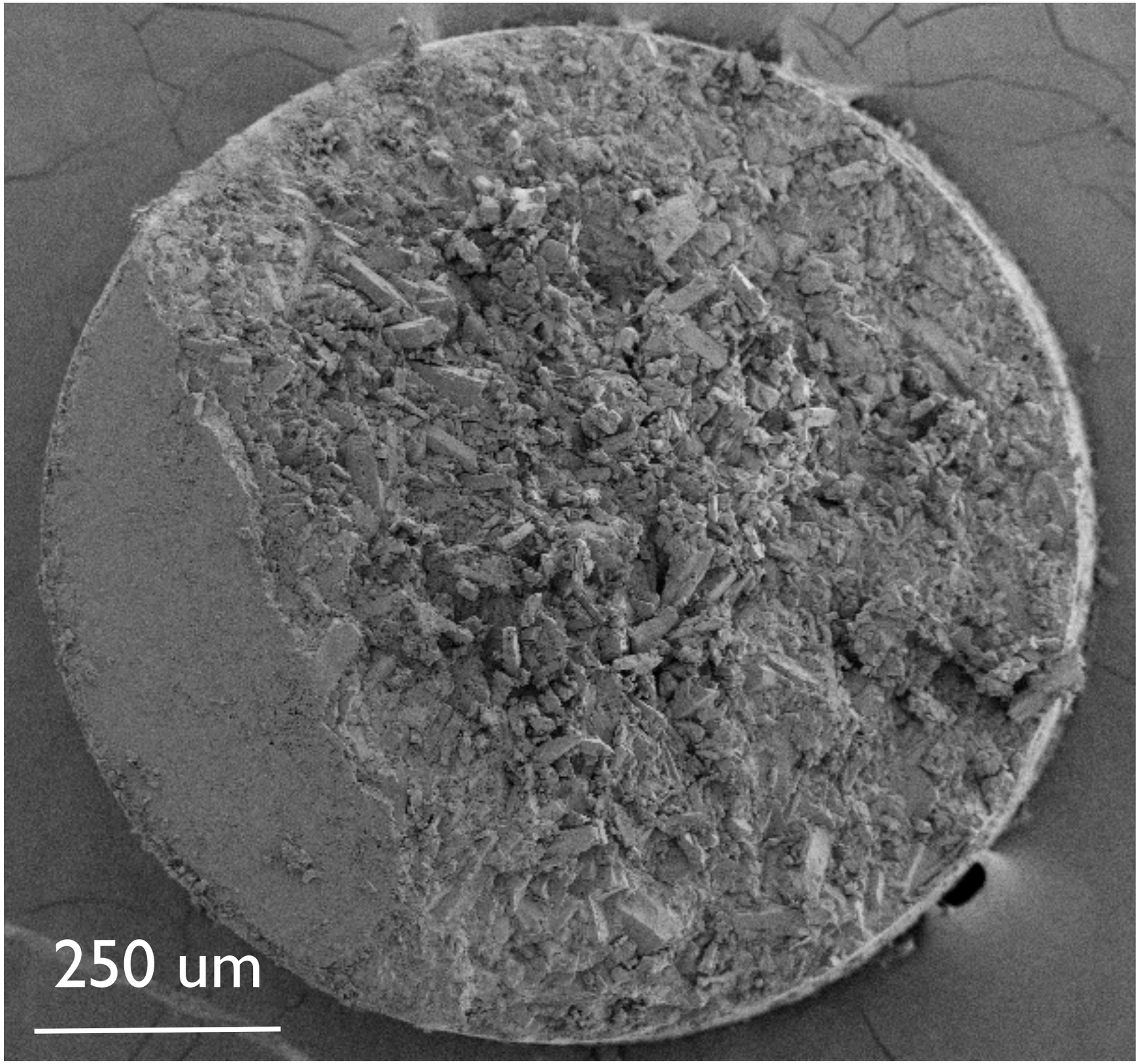
- Microenergetics
- PETN and Vapor Deposition
- Evolution of surface morphology
- What are the appropriate metrics for characterization of micro-scale energetics?
- Three-dimensional nanotomography
- Detonation of microchannels

02: Typical PETN powder



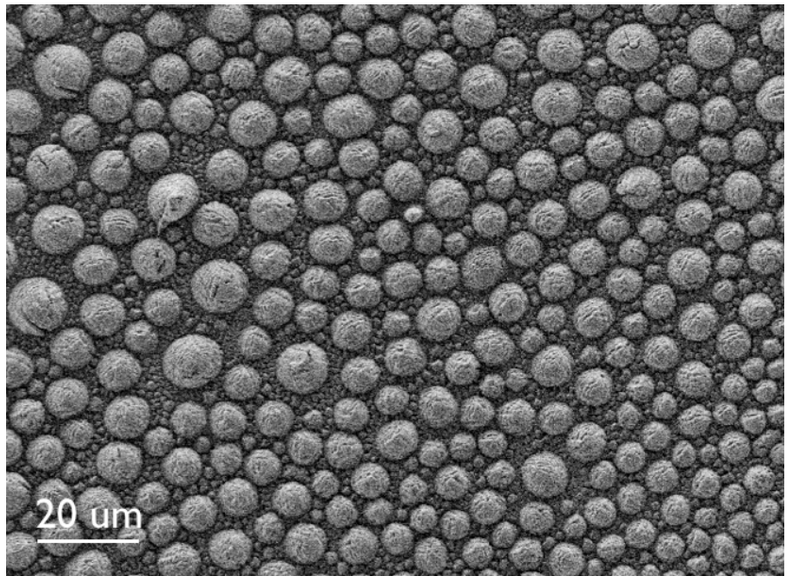


03: PETN Pellet

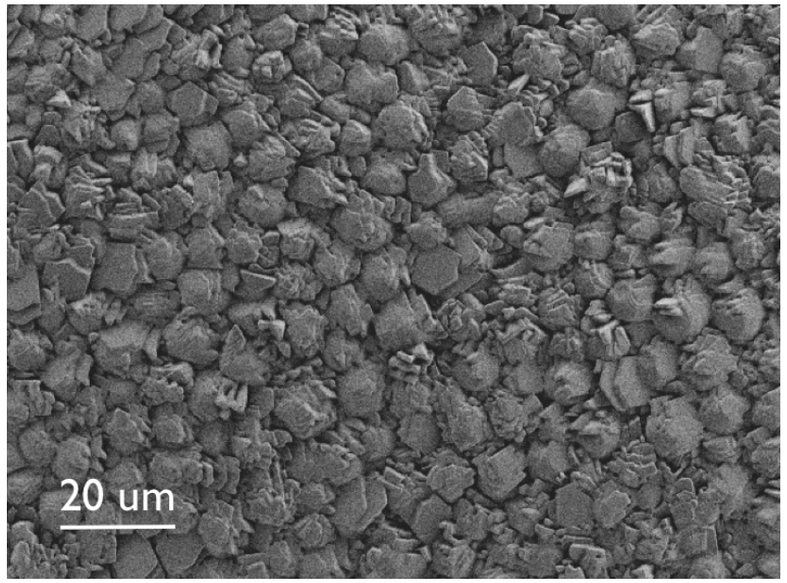


04: Vapor deposited PETN, fused-silica substrates

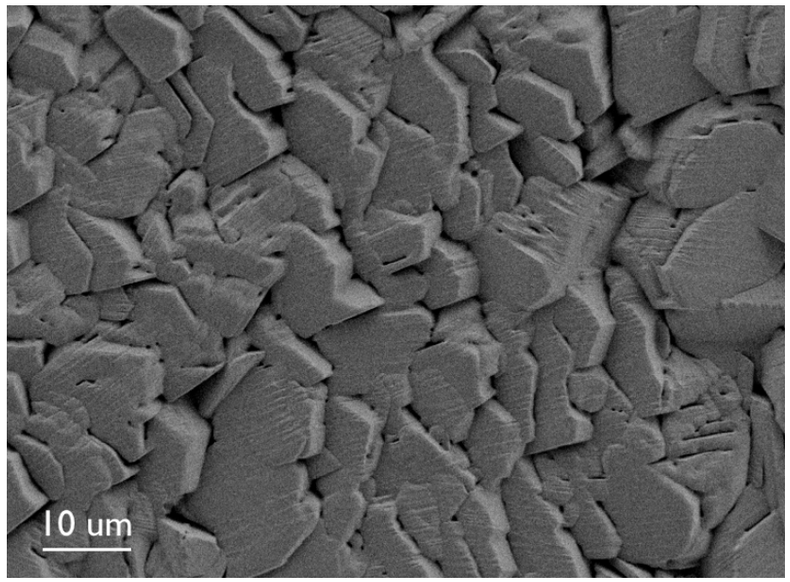
Thickness: 2 um

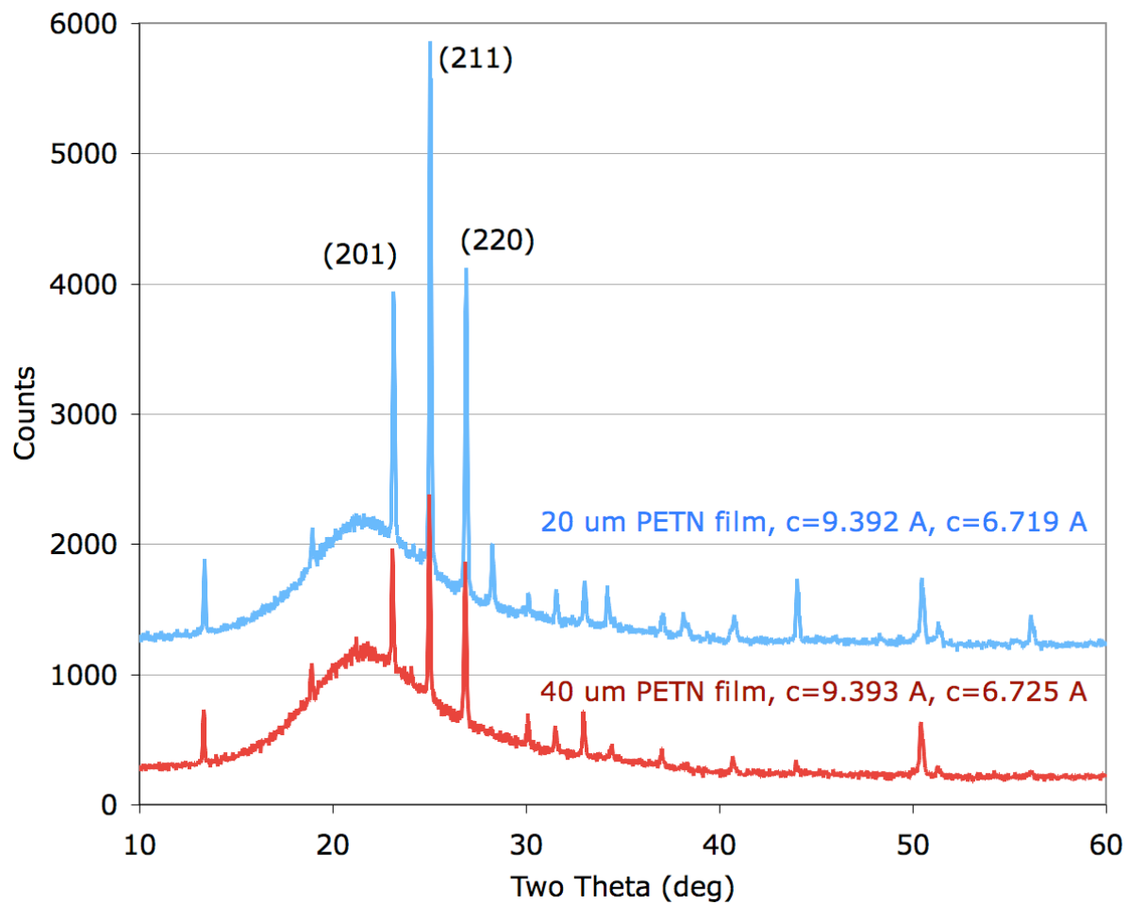


6 um

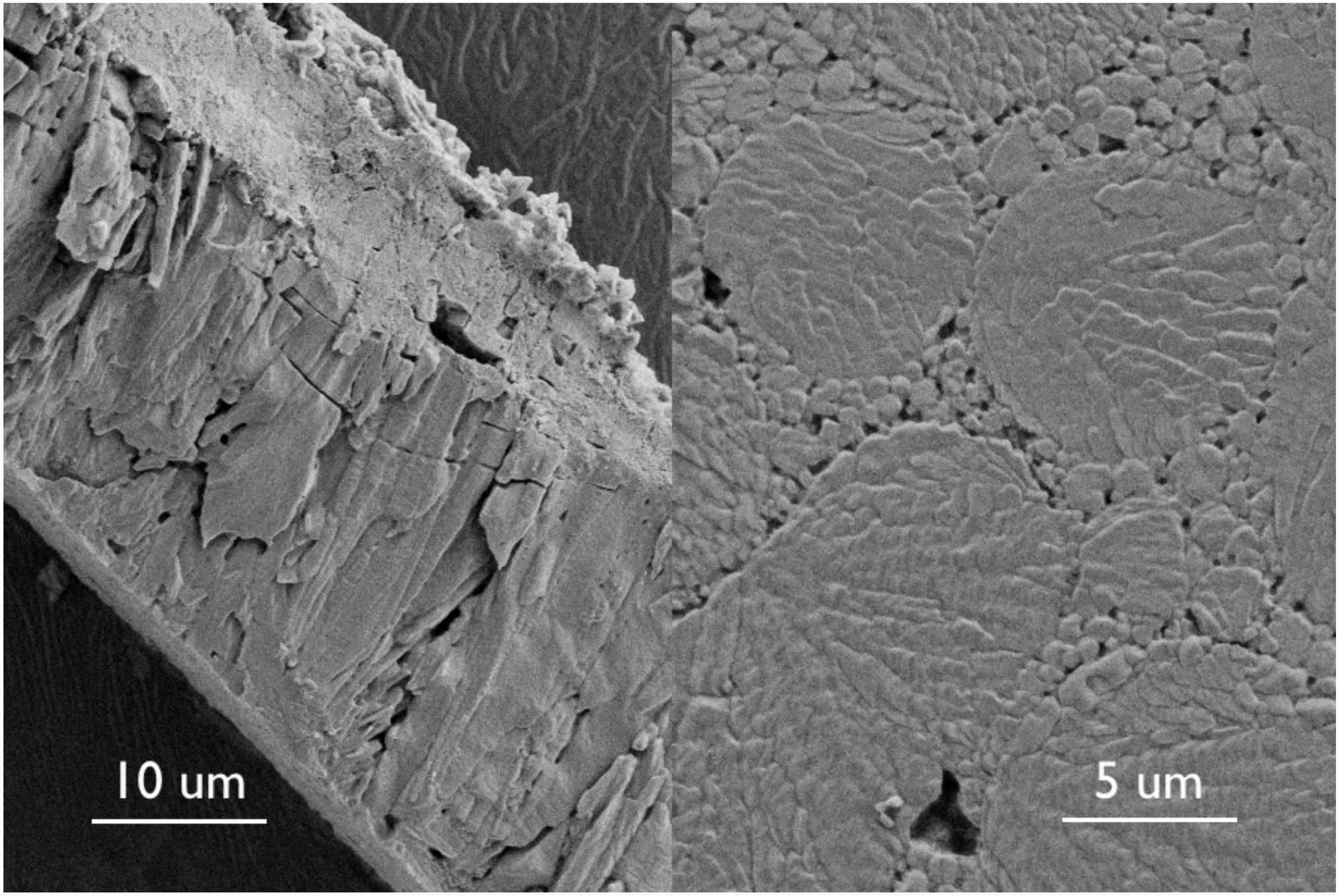


100 um

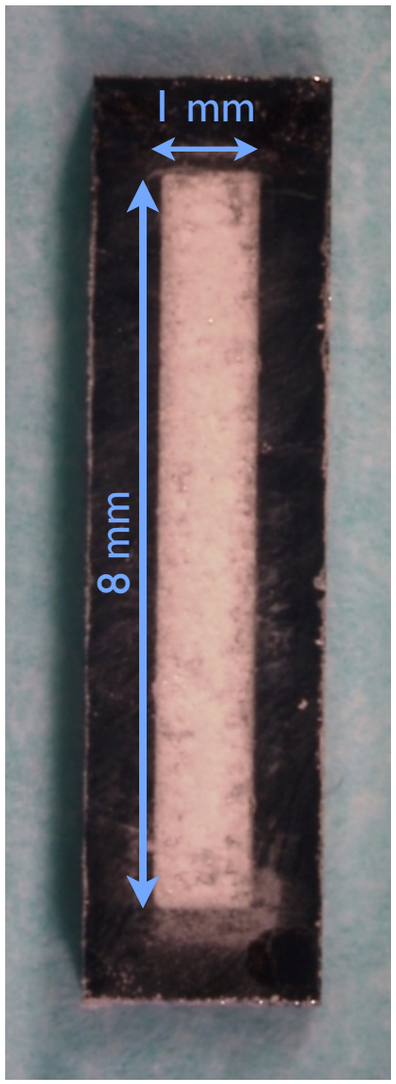


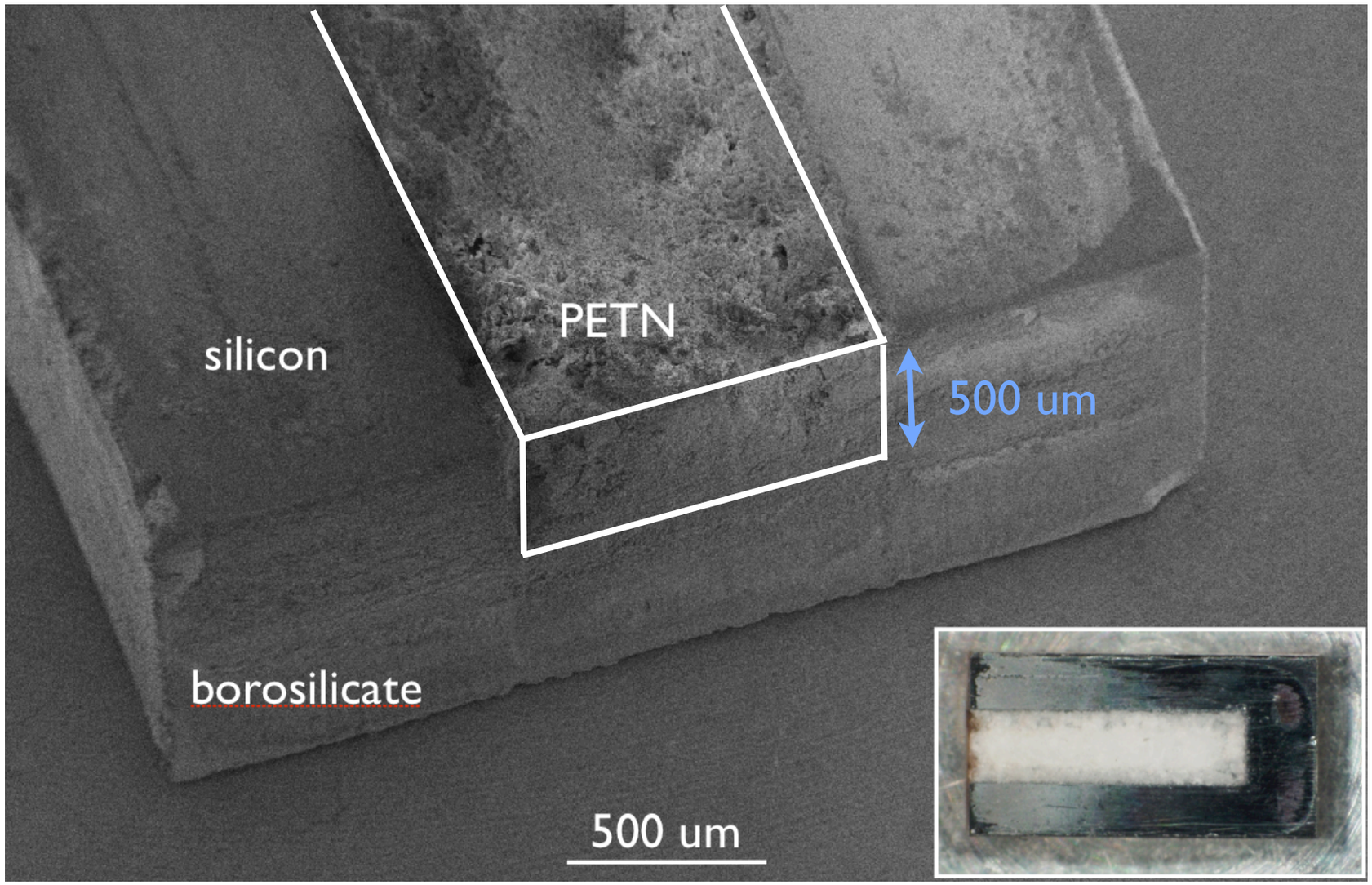


05: Delaminated PETN / x-section and interface



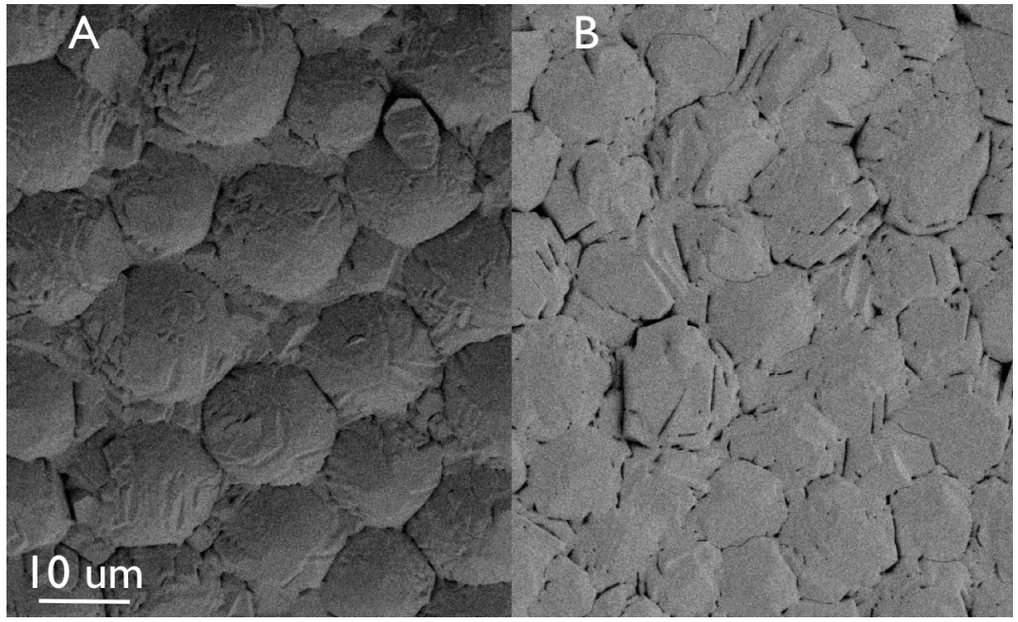
06: Silicon micro-channel / PETN vapor deposition



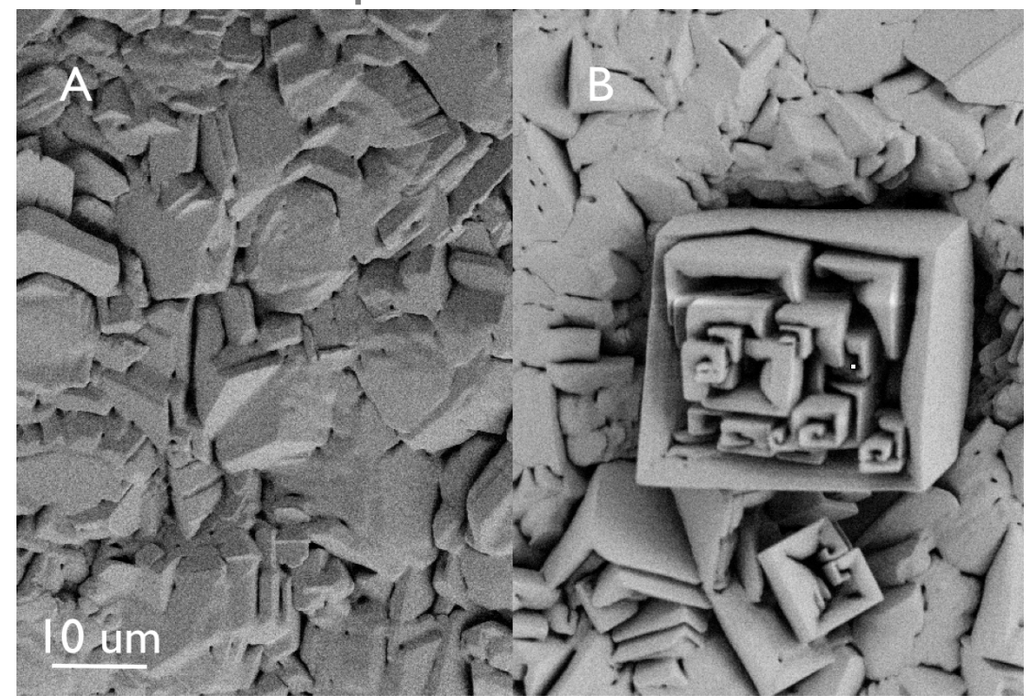


07: Silicon micro-channel: PETN morphology evolution

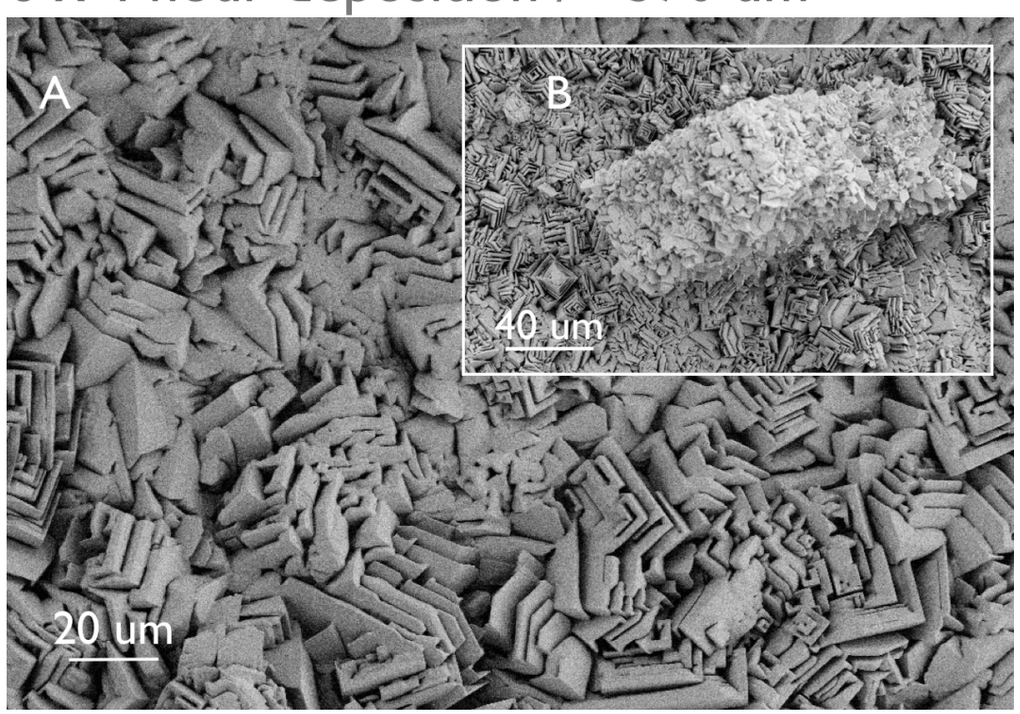
1 x 4 hour deposition / ~5 um



3 x 4 hour deposition / ~250 um

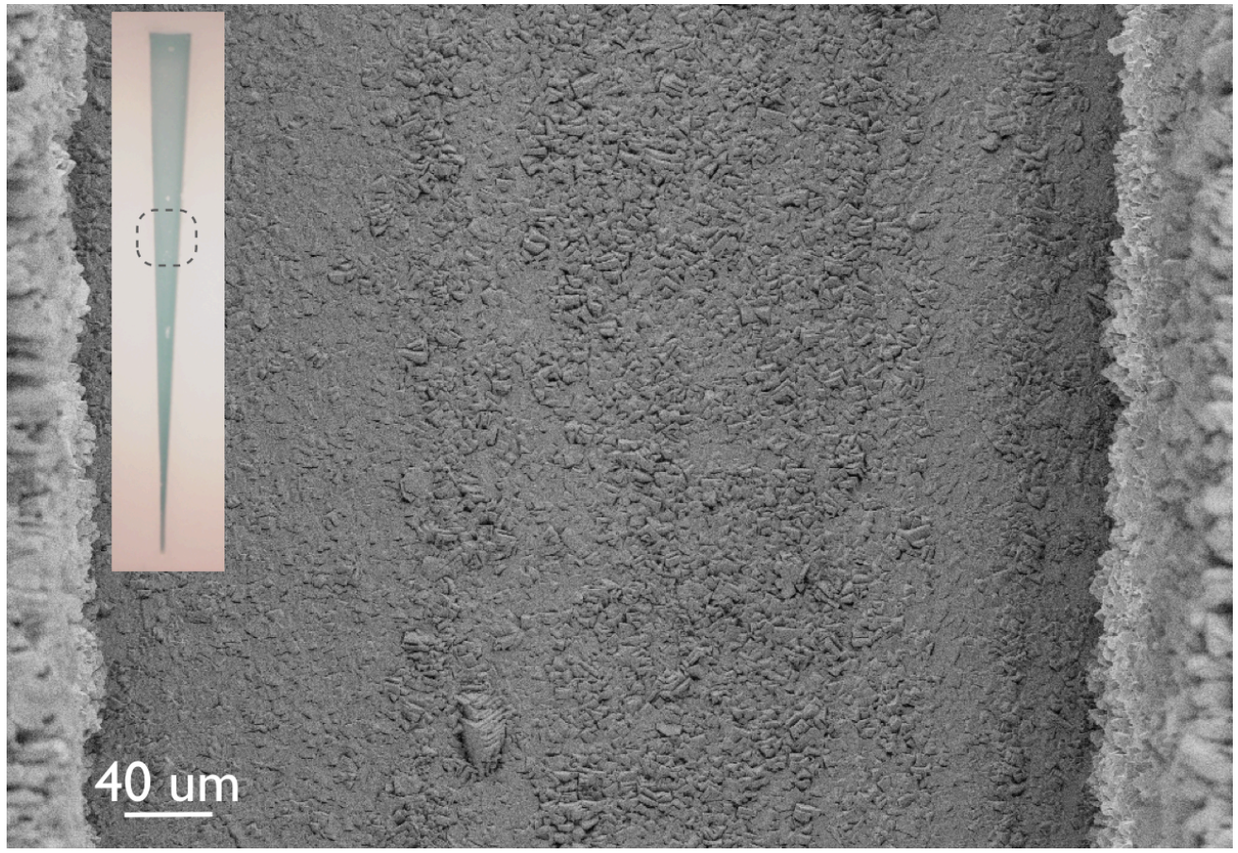


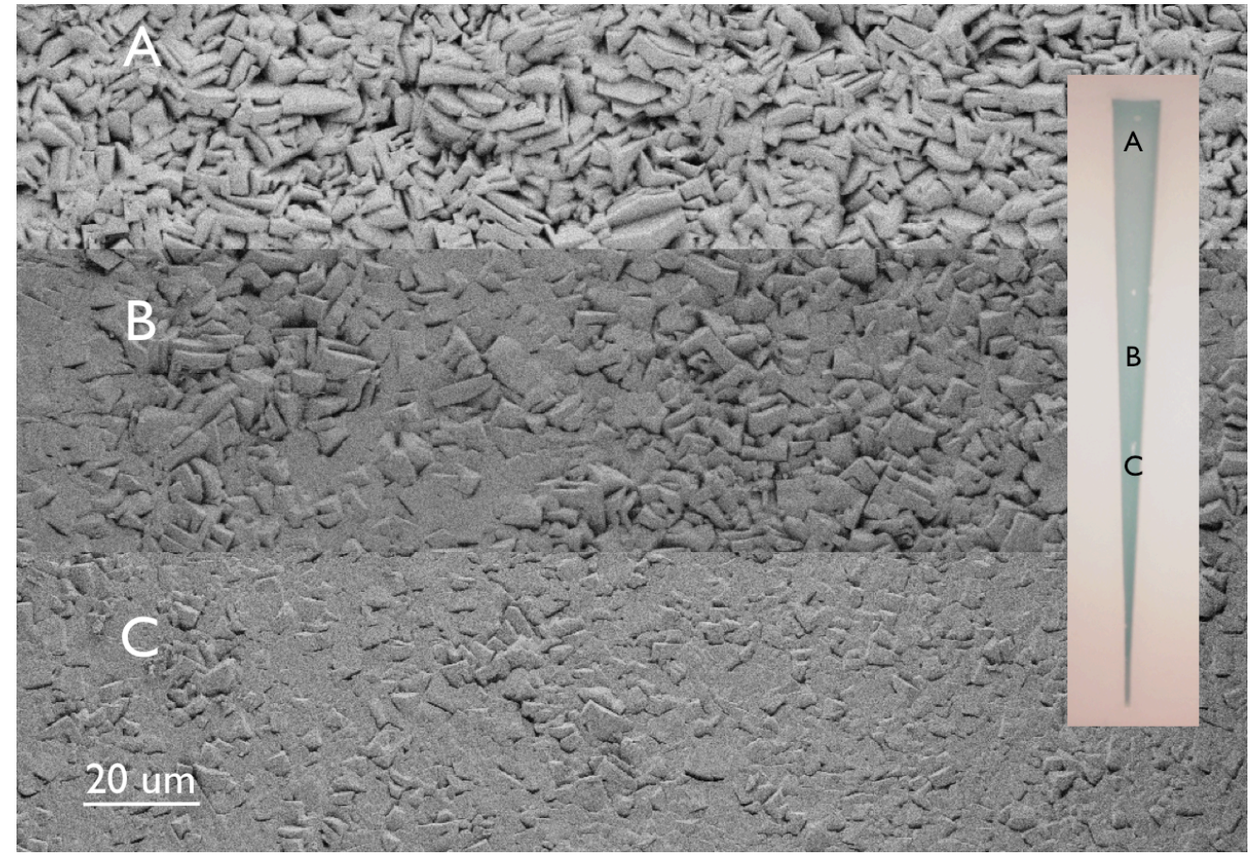
6 x 4 hour deposition / ~370 um

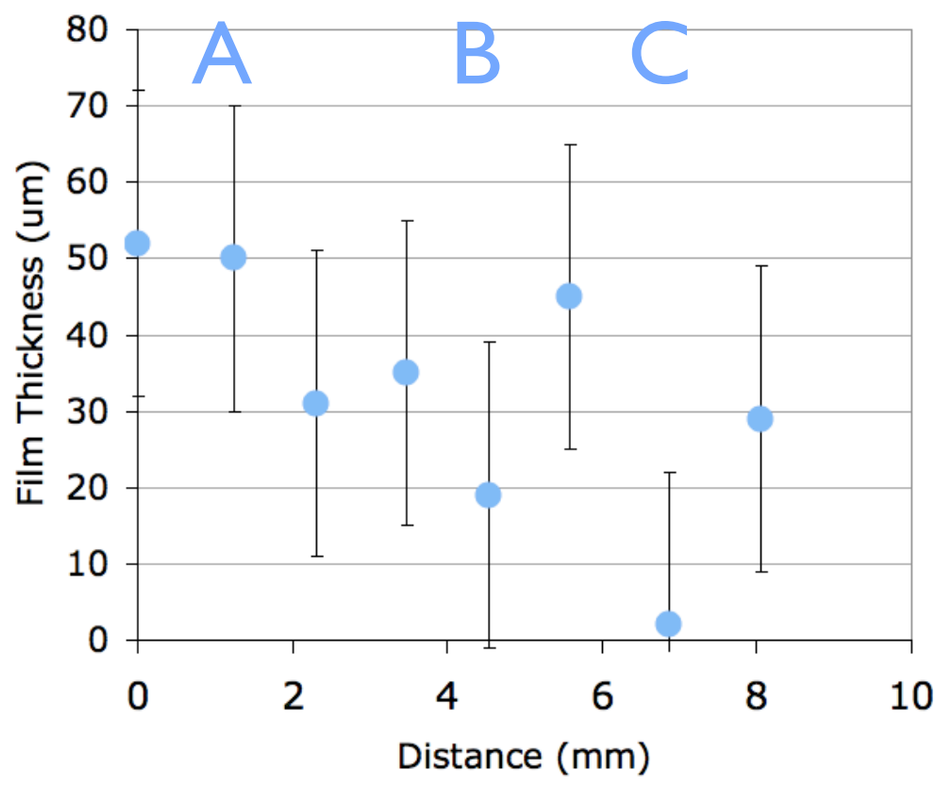


10 x 4 hour deposition / ~500 um

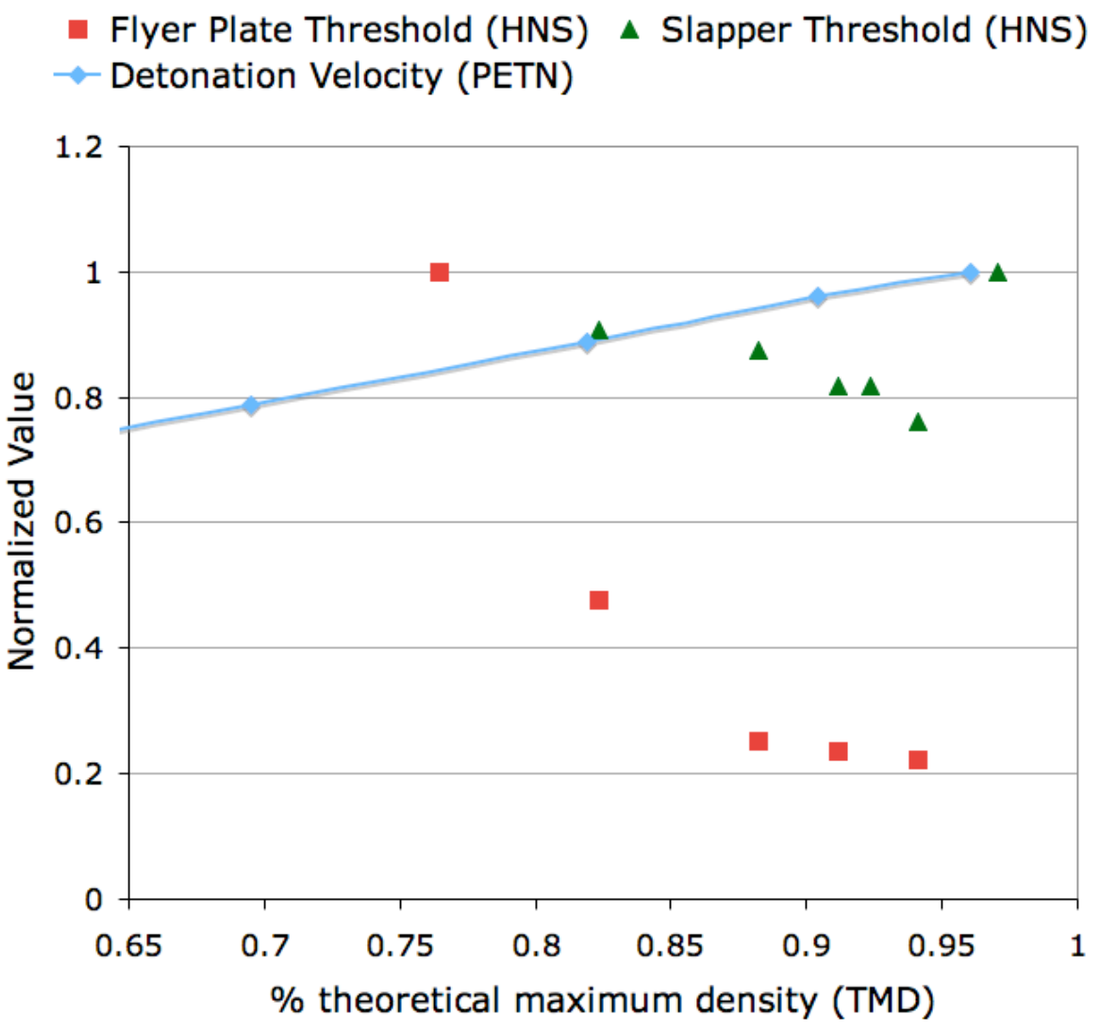
08: PETN morphology vs. channel aspect ratio

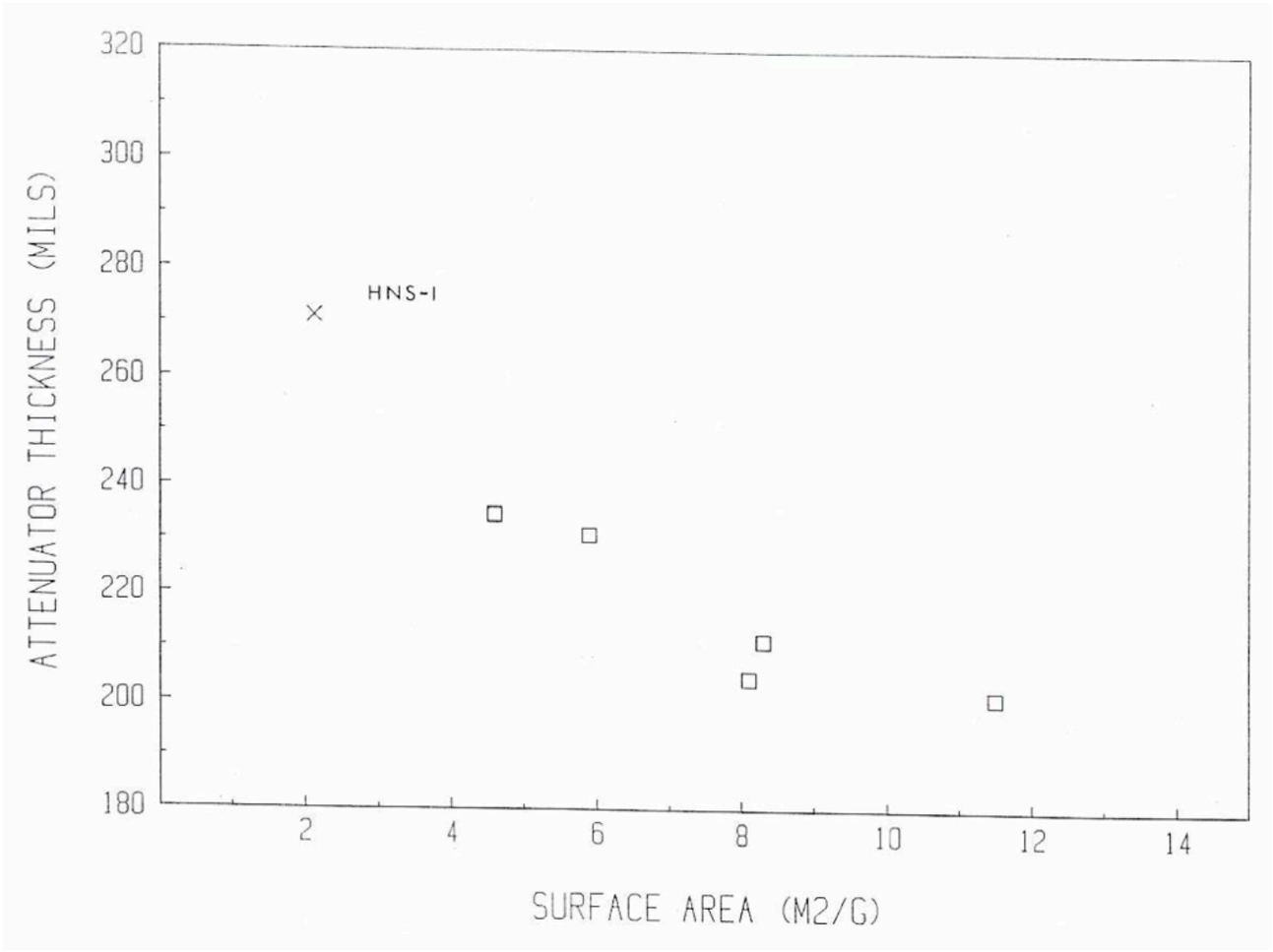




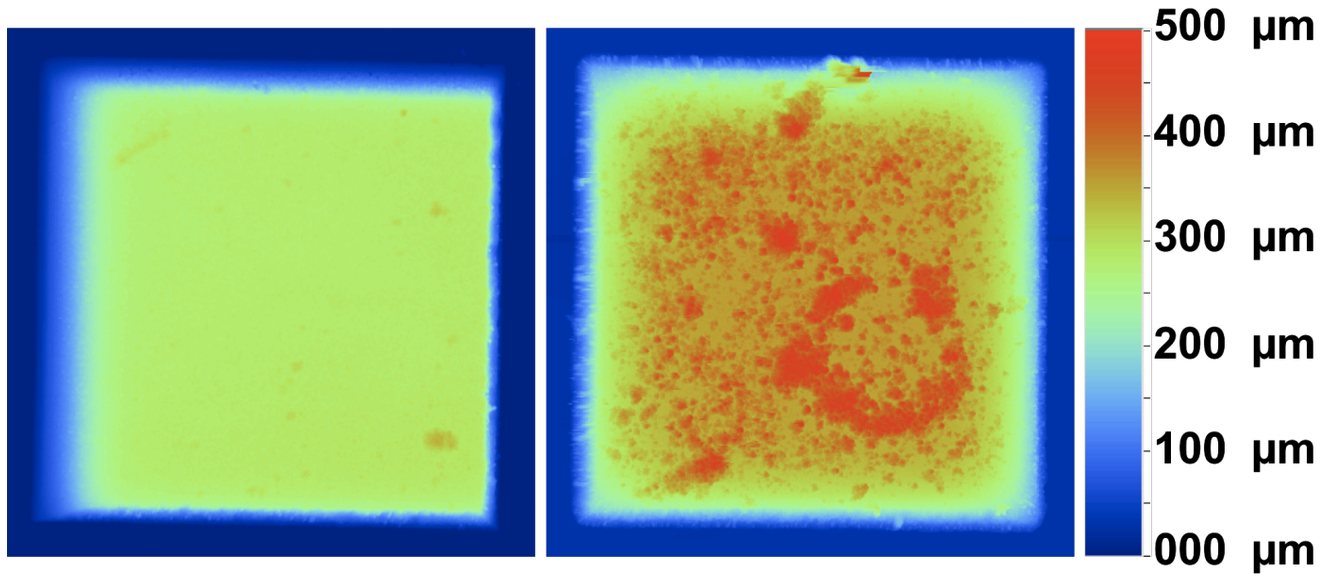


09: Typical metrics: Density and Surface Area



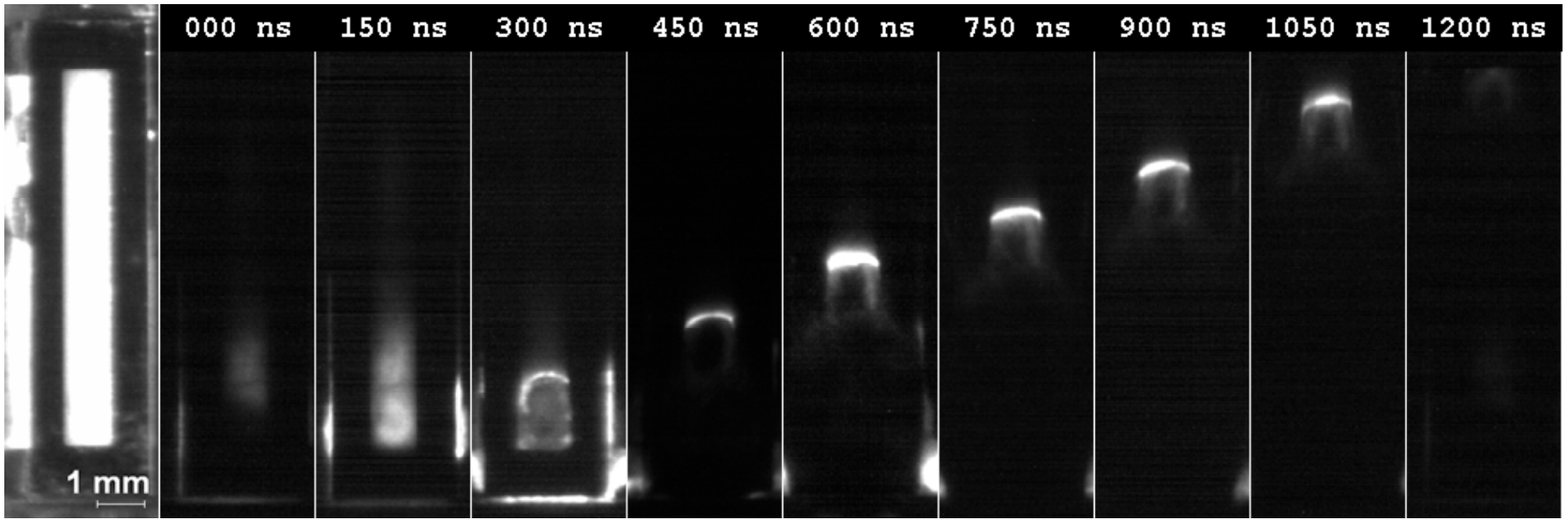


10: Film density from volume and mass measurements



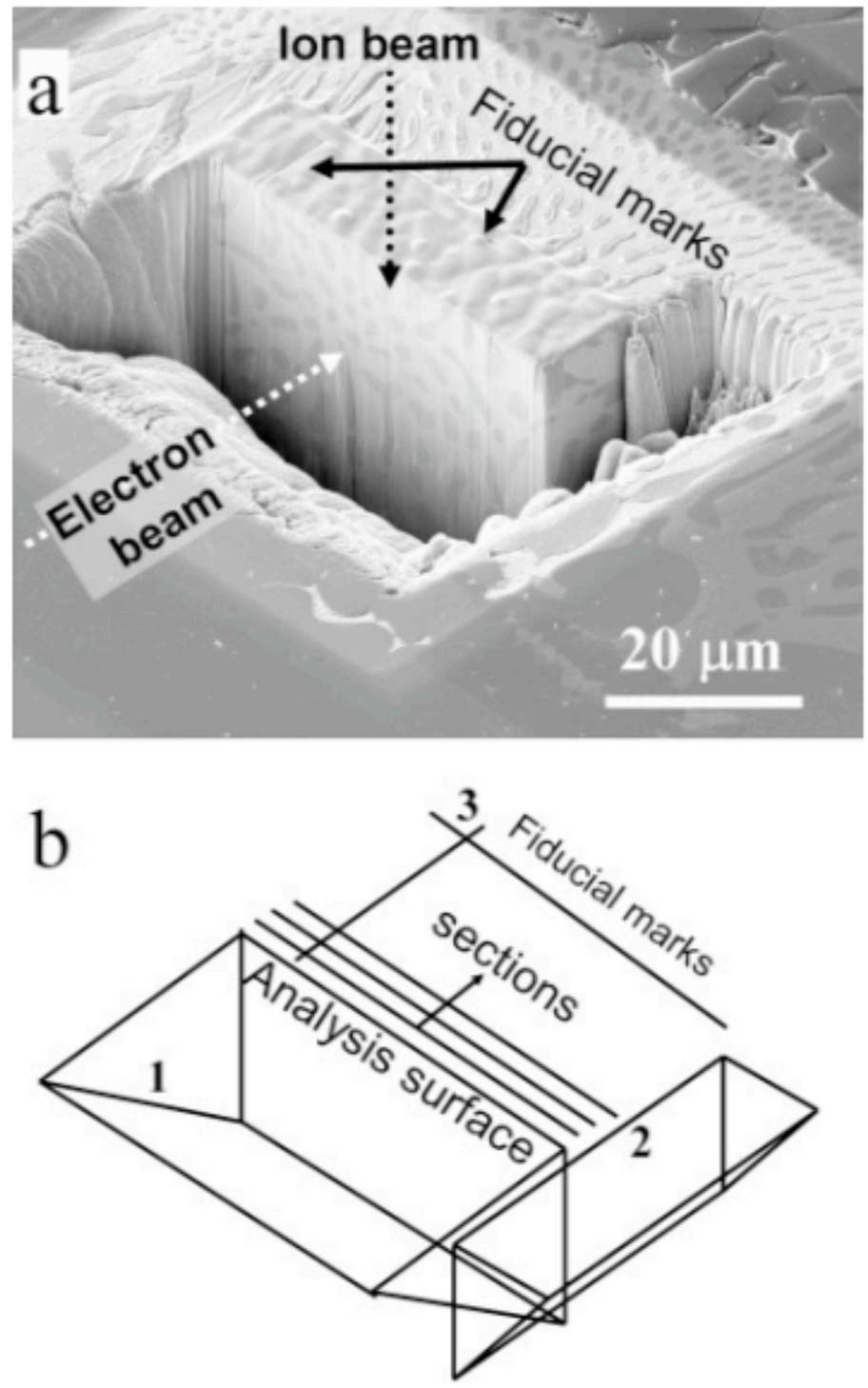
Dep. Number Profile ID	PETN mass mg	Volume mm^3	Density g/cc	% TMD %
SCT281 27	9.887	5.850	1.690	95.05
SCT281 28	9.887	5.829	1.696	95.40
SCT282 29	11.539	7.060	1.634	91.92
SCT282 31	11.539	7.024	1.643	92.40
SCT282 32	11.539	6.998	1.649	92.74
SCT282 33	11.539	6.964	1.657	93.20

11: Detonation of vapor deposited PETN films



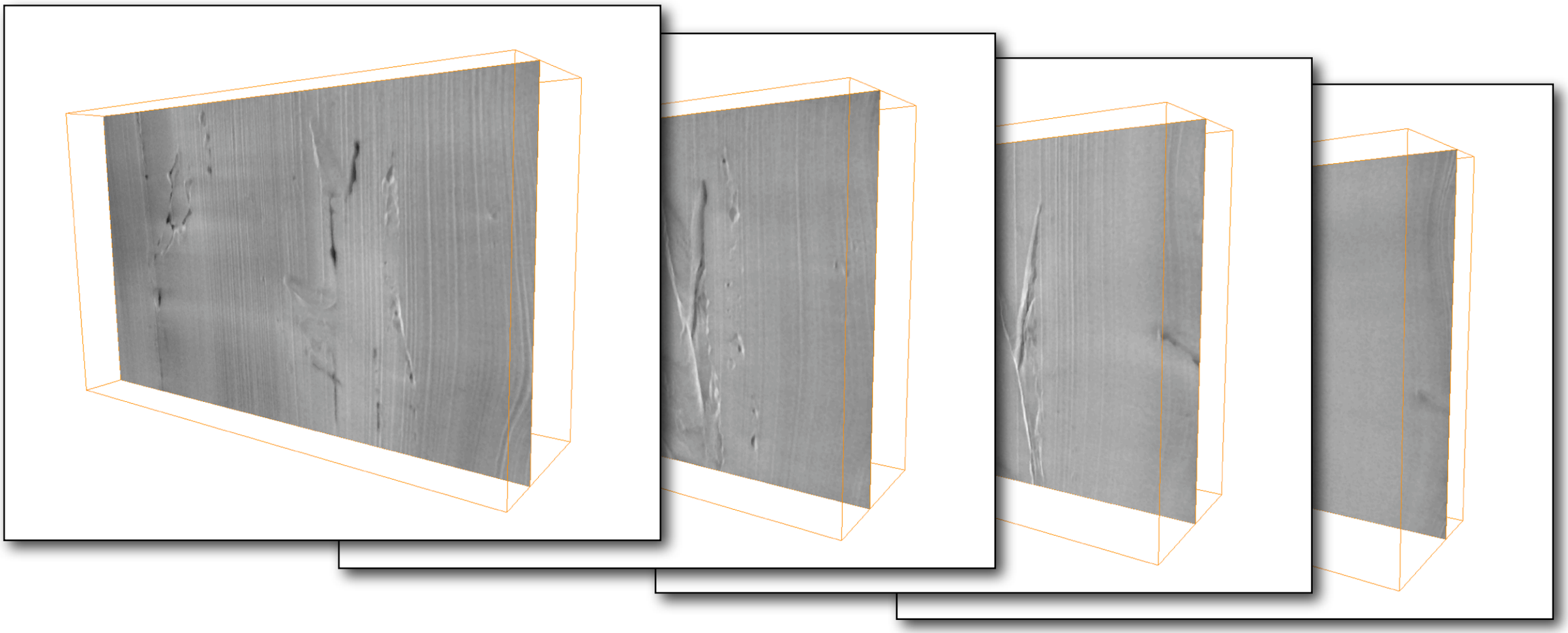
Shot #	Deposition Substrate Temperature °C	Detonation Velocity mm/μs	Error (2*σ) mm/μs
14	25	7.53	0.42
15	50	7.81	0.22
18	25	6.88	0.25
19	50	7.53	0.44

12: Focused Ion Beam (FIB) nanotomography

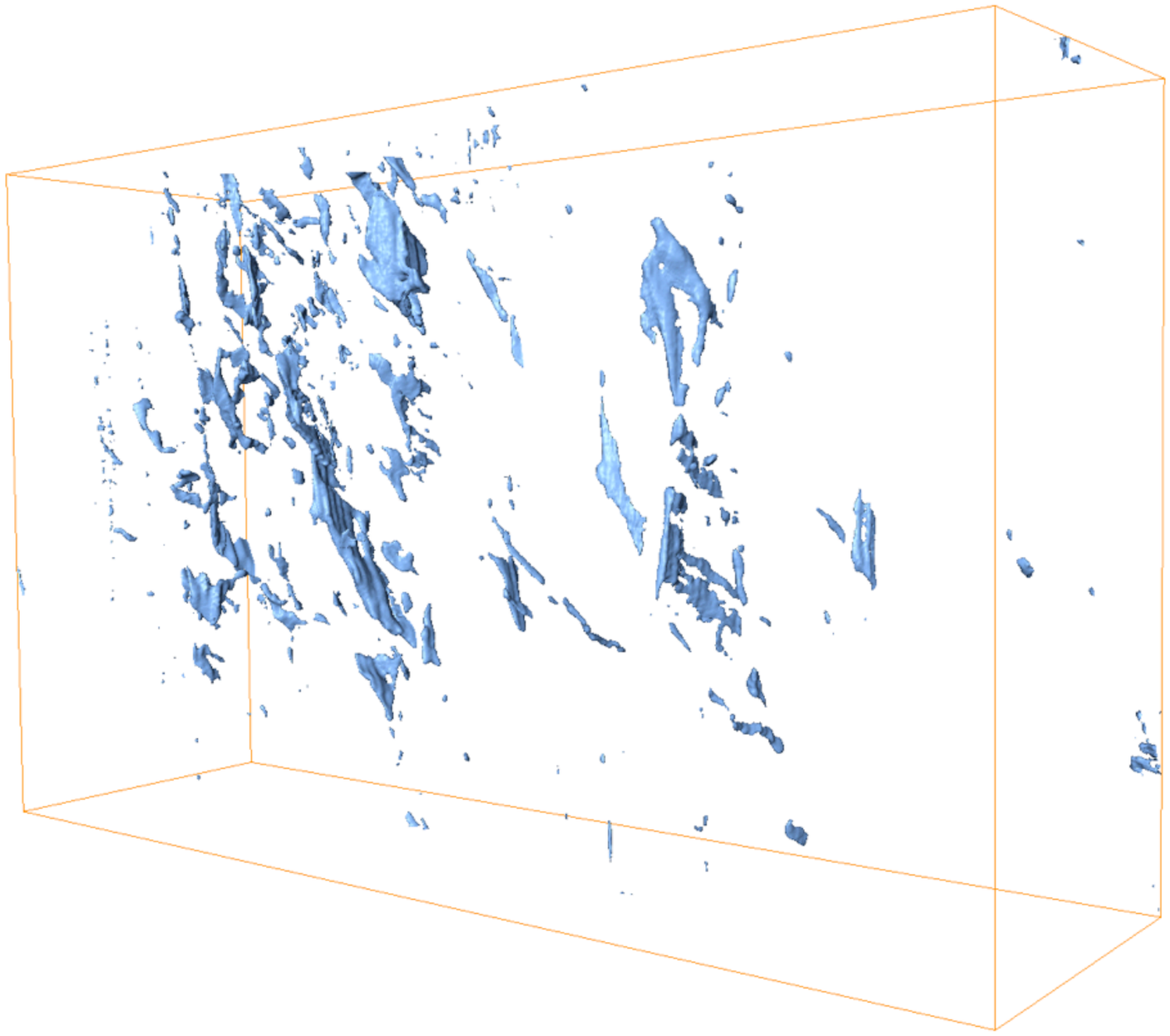


P.G. Kotula, M.R. Keenan, J.R. Michael, Microsc. Microanal. 12, 36-48, 2006

13: FIB nanotomography: PETN within a micro-channel



14: pore morphology, density, and surface area



15: Mesoscale modeling using real microstructural data