Supplementary Information (SI) for Journal of Materials Chemistry A.

Supporting Information

Ultra-Low Ice Adhesion Enabled by Nano-Engineered Poly (ionic liquid)-Elastomeric Films: Leveraging Aqueous Lubrication and Elasticity

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Supporting figures and tables for Results and Discussion

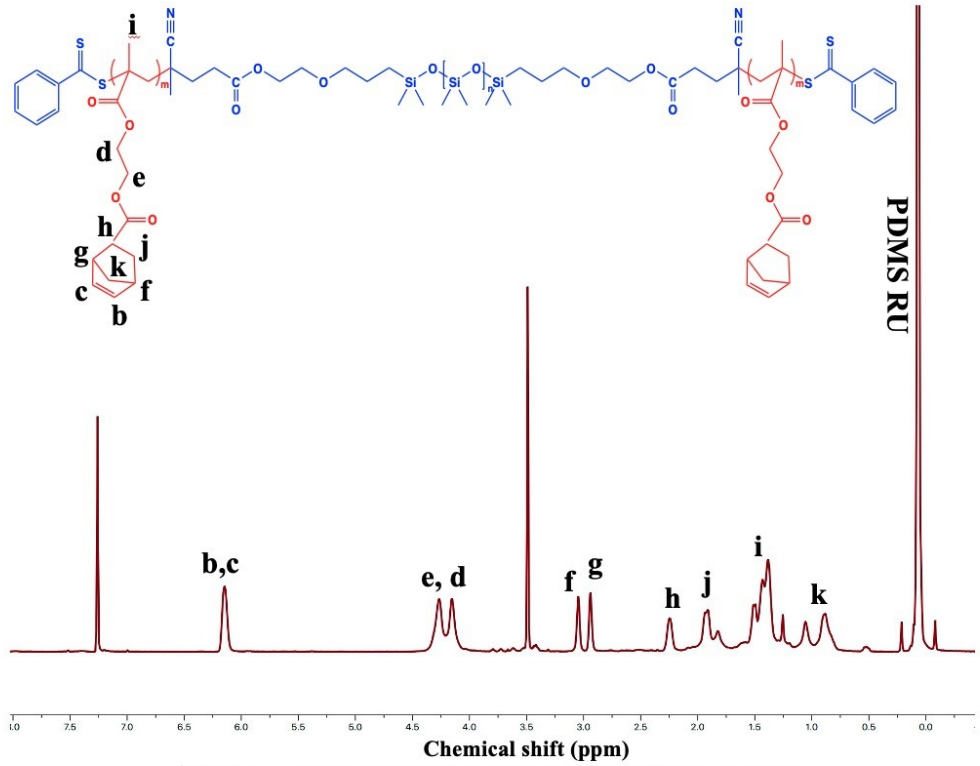


Fig. S1 [1]H NMR spectrum of the triblock copolymer of PDMS-*b*-(PNBMMA)$_2$ (P10 macrocrosslinker) in $CDCl_3$.

Table S1. Composition and molecular weight of the synthesized P5 and P10 macrocrosslinkers.

Designation	Feeding ratio of M: RAFT: I (mol)	DP_n	M_n (×10^4)		PDI	Conv. (%)
			[1]H NMR	GPC		
P5	5:1:0.2	5	1.42	2.1	2.1	90
P10	10:1:0.2	9	1.54	2.4	1.8	91

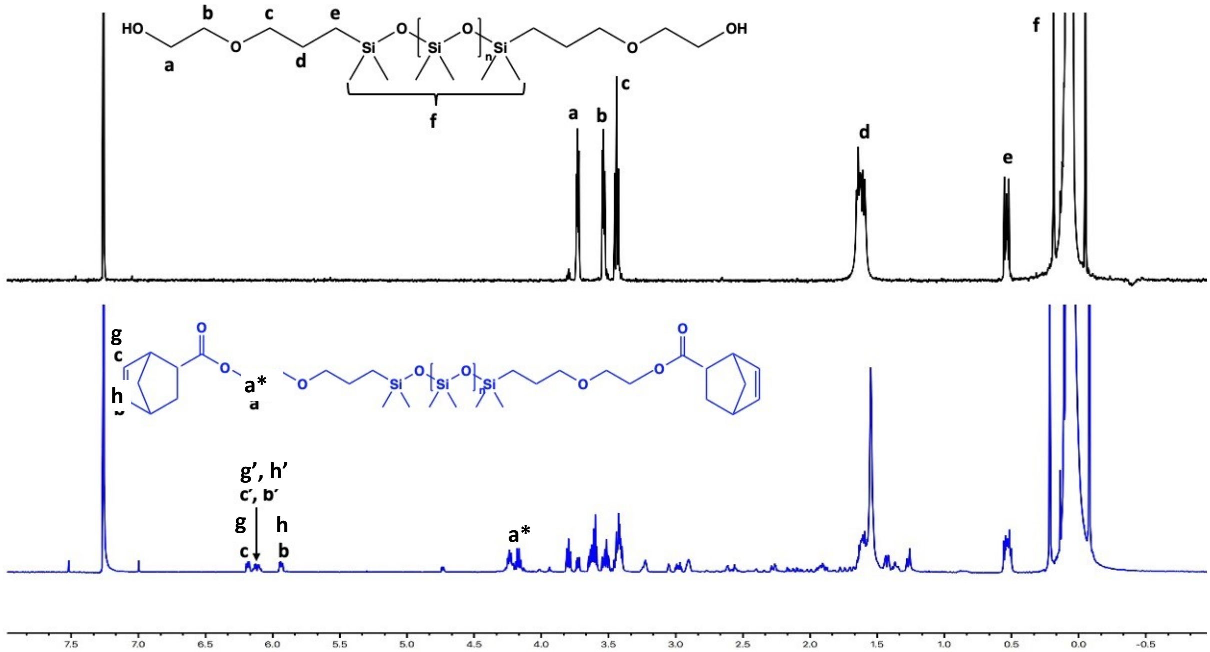
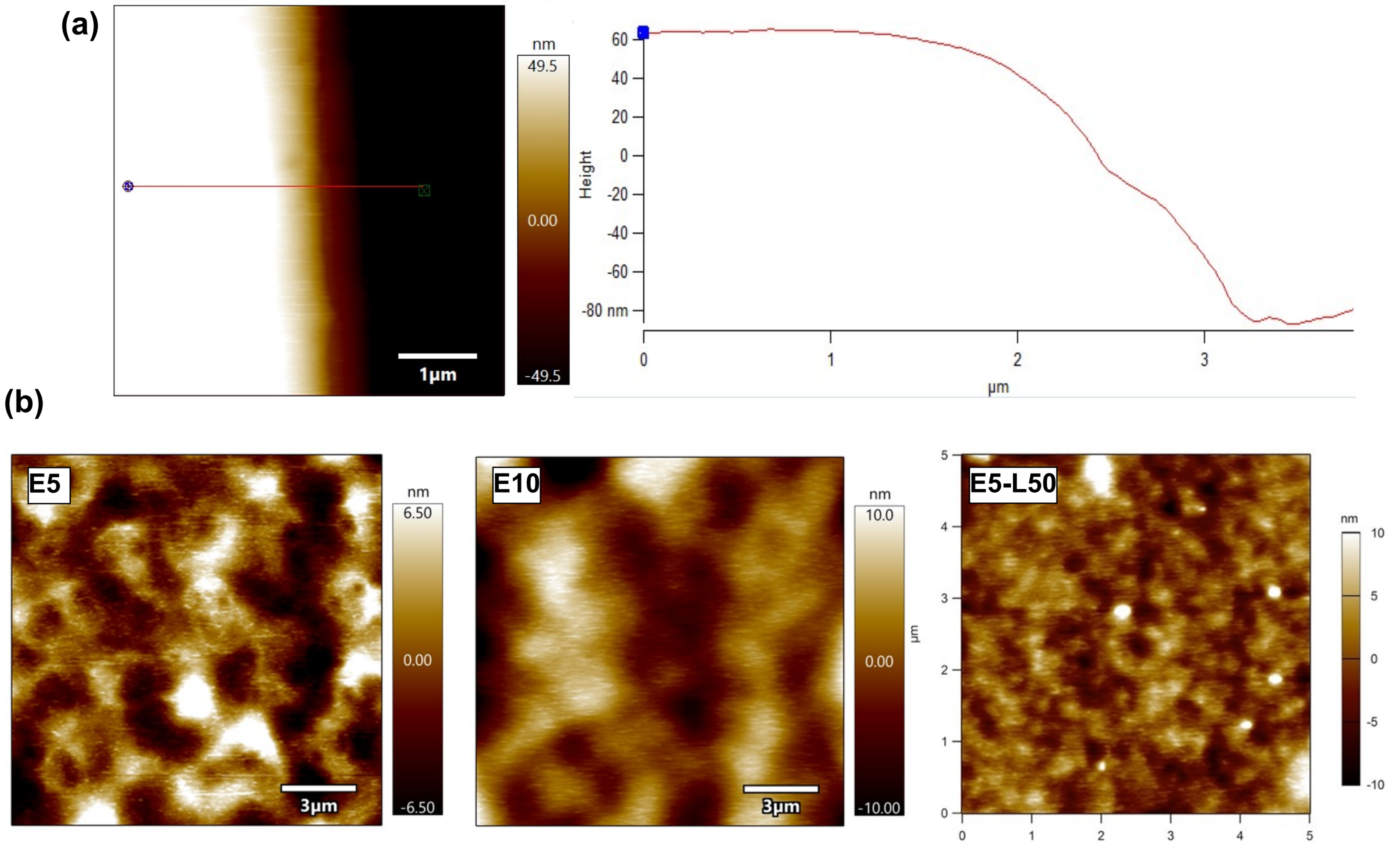


Fig. S2 [1]H NMR spectrum of bis-(hydroxyethyloxypropyl) polydimethylsiloxane and norbornene-terminated PDMS macrocrosslinker (NB-PDMS-NB, P2) in $CDCl_3$.



$RMS = 3.3 \pm 2.6\ nm$ $RMS = 3.9 \pm 3.2\ nm$ $RMS = 6.2 \pm 3.2\ nm$

Fig. S3 (a) Thickness estimation using AFM scratch technique, and (b) AFM height images of elastomers and PIL-infused elastomers.

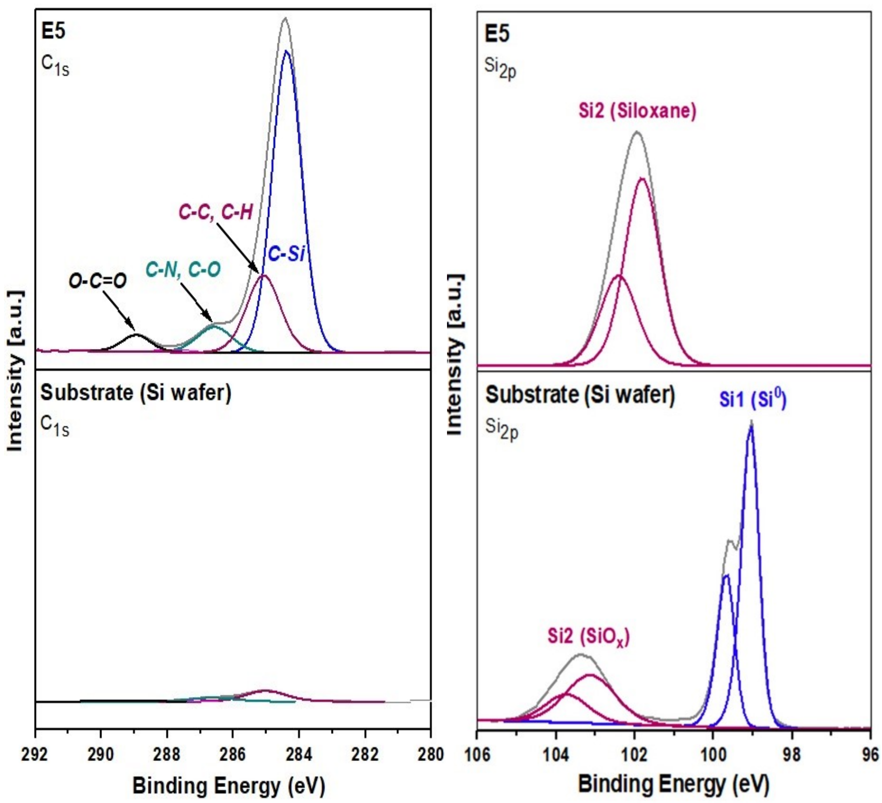
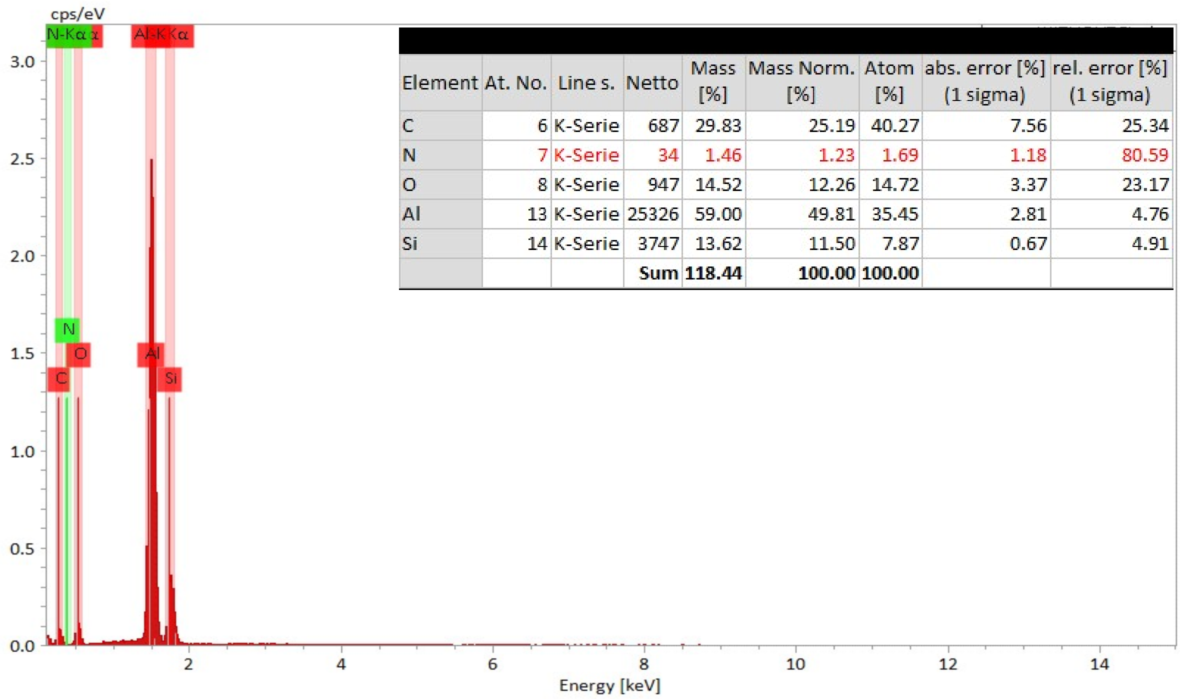


Fig. S4 X-ray photoelectron spectroscopy (XPS) data (i.e., C1s and Si 2p high resolution spectra) of the substrate and surface-tethered E5 elastomer.

Table S2. Elemental composition (%) of the substrate and E5 elastomer obtained by $ssCAP_{ROMP}$ process determined by X-ray photoelectron. spectroscopy (XPS) analysis.

	Substrate (Silicon Wafer)		E5		Assignments
Atomic %	**Mean**	***std***	**Mean**	***Std***	
O	38.0	*7.1*	24.5	*0.2*	
N (total)	0.1	*0.1*	0.2	*0.0*	
N1			0.2	*0.0*	*All organic N other than N^{+}, NO_x*
N2			0.0	*0.0*	*N^{+}*
N3			0.0	*0.0*	*NO_x*
C (total)	5.6	*0.2*	56.1	*0.2*	
C1	0.0	*0.0*	37.4	*0.7*	*C-Si*
C2	*3.8*	*0.2*	11.9	*0.8*	*C-C, C-H*
C3	*1.3*	*0.2*	4.0	*0.0*	*C-N, C-O*
C4	*0.1*	*0.0*	0.5	*0.1*	*C=O, N-C=O*
C5	*0.4*	*0.0*	2.1	*0.1*	*O-C=O*
Si	56.2	*7.4*	18.7	*0.1*	
Si1	*34.4*	*8.6*	0.1	*0.1*	*Si^0 i.e., Si-Si*
Si2	*21.8*	*1.2*	18.6	*0.0*	*Siloxane, SiO_x*
Si2/Si1	*0.6*		*289.7*		*Film thickness/contribution for the E5*
Si2/C			*0.33*		*PDMS assignment check in E5*

(a)



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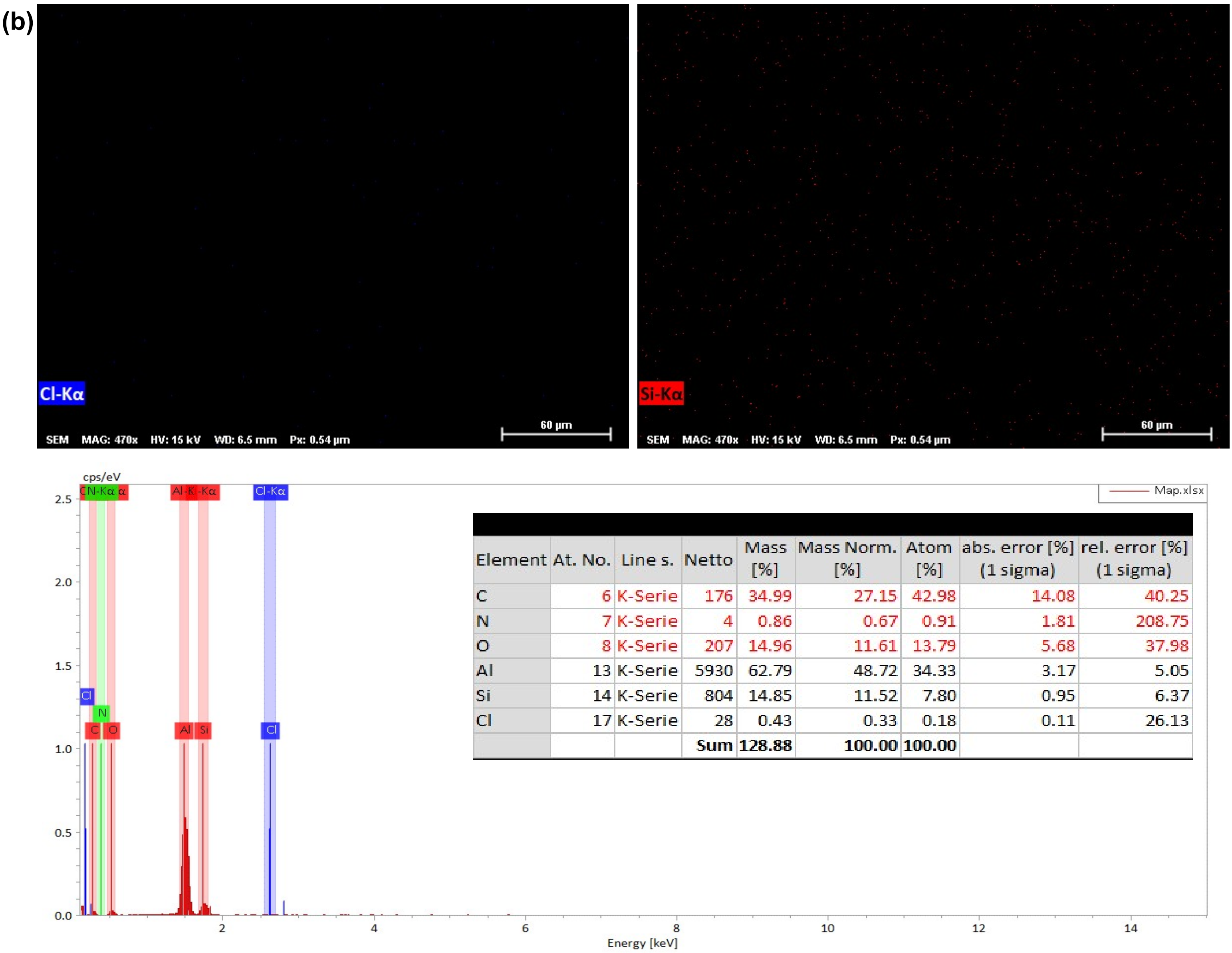
Element	At. No.	Line s.	Netto	Mass [%]	Mass Norm. [%]	Atom [%]	abs. error [%] (1 sigma)	rel. error [%] (1 sigma)
C	6	K-Serie	687	29.83	25.19	40.27	7.56	25.34
N	7	K-Serie	34	1.46	1.23	1.69	1.18	80.59
O	8	K-Serie	947	14.52	12.26	14.72	3.37	23.17
Al	13	K-Serie	25326	59.00	49.81	35.45	2.81	4.76
Si	14	K-Serie	3747	13.62	11.50	7.87	0.67	4.91
			Sum	118.44	100.00	100.00		



Element	At. No.	Line s.	Netto	Mass [%]	Mass Norm. [%]	Atom [%]	abs. error [%] (1 sigma)	rel. error [%] (1 sigma)
C	6	K-Serie	176	34.99	27.15	42.98	14.08	40.25
N	7	K-Serie	4	0.86	0.67	0.91	1.81	208.75
O	8	K-Serie	207	14.96	11.61	13.79	5.68	37.98
Al	13	K-Serie	5930	62.79	48.72	34.33	3.17	5.05
Si	14	K-Serie	804	14.85	11.52	7.80	0.95	6.37
Cl	17	K-Serie	28	0.43	0.33	0.18	0.11	26.13
			Sum	128.88	100.00	100.00		

Fig. S5 Energy Dispersive X-ray (EDX) analysis of the coatings: (a) E2 Elastomeric film, and (b) E2-L20 film demonstrating elemental mapping of silicon and chlorine over the surface of the film.

Table S3. Surface wettability results of the fabricated elastomers and E2-L20 PIL-infused elastomer.

Designation	Static CA (°)	Advancing CA (°)	Receding CA (°)	Hysteresis (°)
E10	104.9 ± 2.7	110.3 ± 0.8	63.9 ± 0.7	46.4 ± 3.0
E5	99.6 ± 1.4	106.7 ± 0.5	65.9 ± 2.5	40.8 ± 8.8
E2	105.5 ± 0.5	110.1 ± 0.3	71.7 ± 0.9	38.4 ± 1.4
E2-L20	102.5 ± 3.5	109.5 ± 0.3	85.2 ± 1.7	26.5 ± 15.5

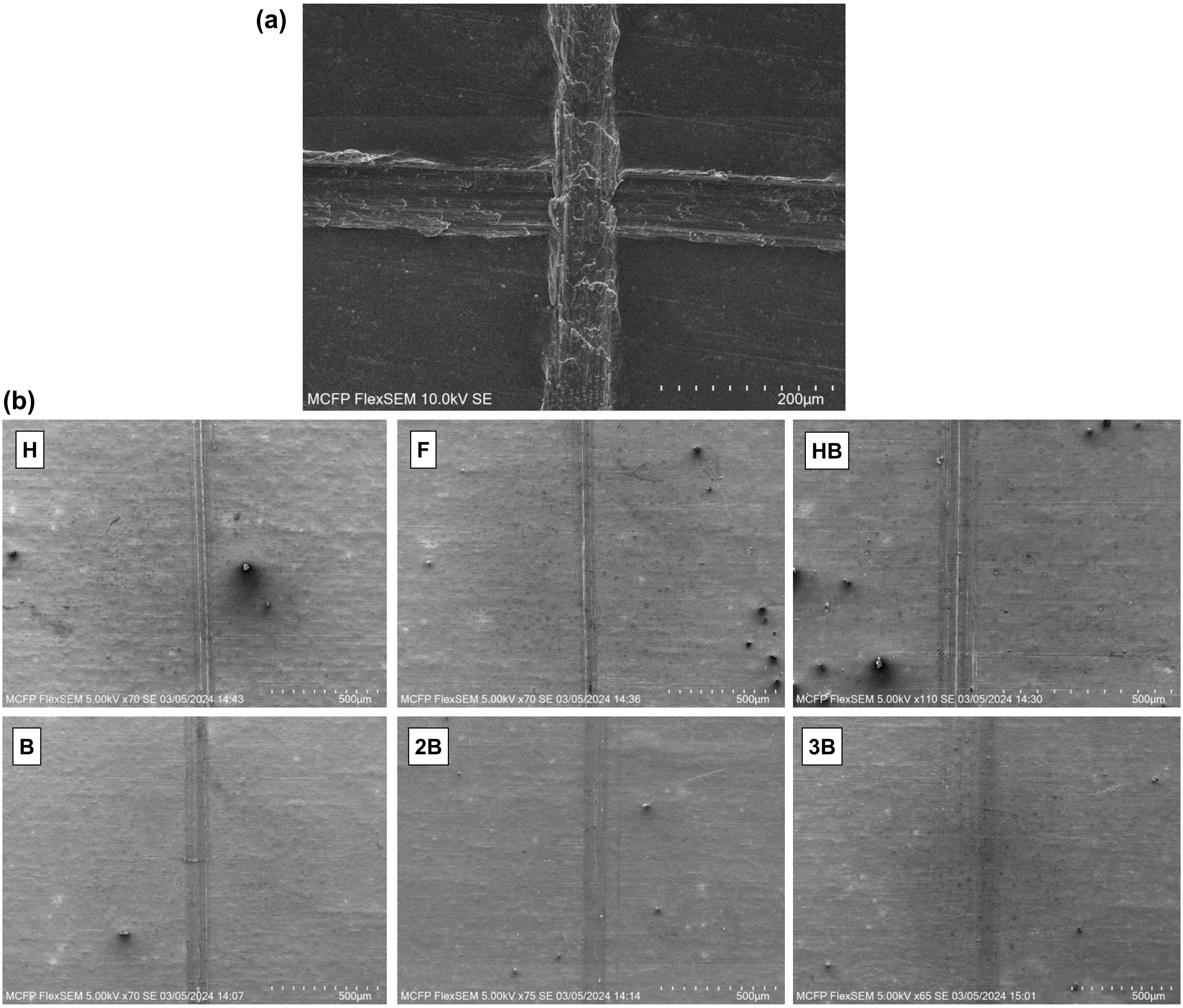


Fig. S6 Mechanical durability assessment of the E2-L20 PIL-infused film: (a) FESEM image of the surface after the crosshatch test, and (b) FESEM images of the films subjected to scratching with pencils of different hardness grades (i.e., pencil hardness test). The sequence of hardness ranges from hardest to softest: H, F, HB, B, 2B, 3B.