Supplementary Materials
Integration of Stable Ionic Liquid-Based Nanofluids into Polymer Membranes. Part I: Membrane Synthesis and Characterization

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Table S1. Identification of bands corresponding to the graphene [S1-S3].

Description	Wavenumber (cm^{-1})
$=CH_2$ asymmetric and symmetric stretching	2915 and 2850
C-H bond stretching and bending	3783 and 672
C=C sp^2 bonds	1618
Adsorption of CO_2 from air	2300

Table S2. Identification of bands corresponding to the ionic liquid [S4,S5].

Description	Wavenumber (cm^{-1})
C-H bond tension	2850-3000
Pyridinium ring vibration	1600-1650
C=N bond tension, Pyridinium ring	1520-1450
CF_2 tension group	1240-1260
CF_2 tension group	1130
SO_3 tension group	1055, 1035, 1020
Pyridinium ring tension	1000-1030
SO_3 flexion group	600-700
O=S=O flexion of SO_3 group	520-530

Table S3. Identification of bands corresponding to Pebax®1657 [S6].

Composition	N-H bond tension	O-H bonds tension	C-H bonds tension	C=O bonds tension	HNCO tension	N-H flexion	C-O-C bond tension
Pebax	3296.5	3506	2850-3000	1731	1637	1542	1094
Pebax/20IL	3295.7	3520	2850-3000	1731	1637	1543	1101
Pebax/40IL	3297	3523	2850-3000	1731	1637	1543	1098
Pebax/60IL	3298	3520	2850-3000	1731	1638	1543	1099
Pebax/19.8IL/0.2xGnP	3296	3520	2850-3000	1731	1637	1542	1100
Pebax/18IL/0.2xGnP	3296	3519	2850-3000	1731	1637	1542	1097
Pebax/16IL/4xGnP	3296	3520	2850-3000	1731	1637	1542	1094
Pebax/32IL/8xGnP	3296.5	3521	2850-3000	1731	1637	1542	1094
Pebax/48IL/12xGnP	3296.5	3520	2850-3000	1731	1637	1543	1097

[1] Values in cm^{-1}

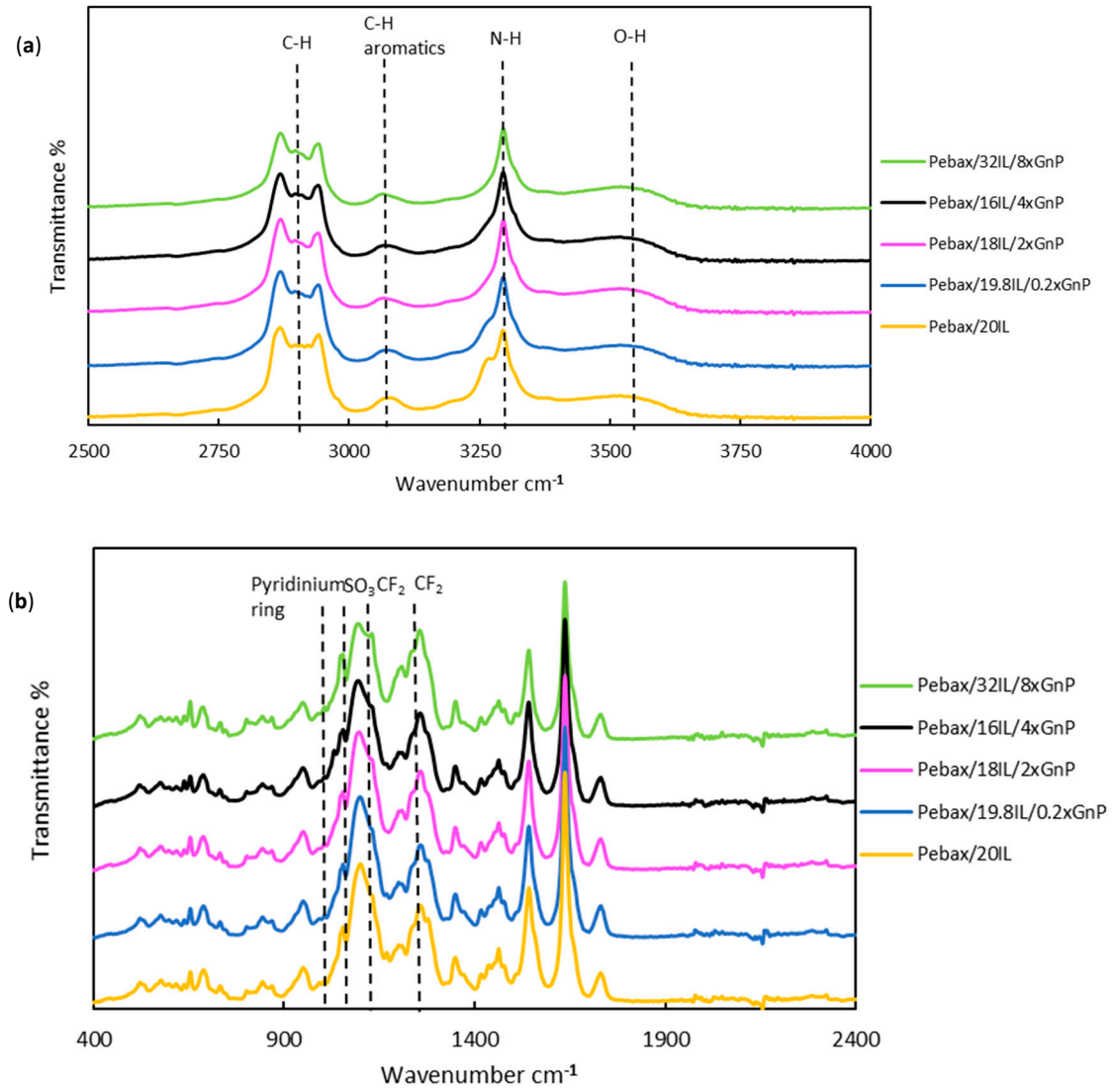


Figure S1. Comparison between CILPM Pebax/20IL and MMMs (full names in Table 1) with differences concentrations of IL and xGnP: a) range 2500-4000cm^{-1}, b) range 400-2400cm^{-1}.

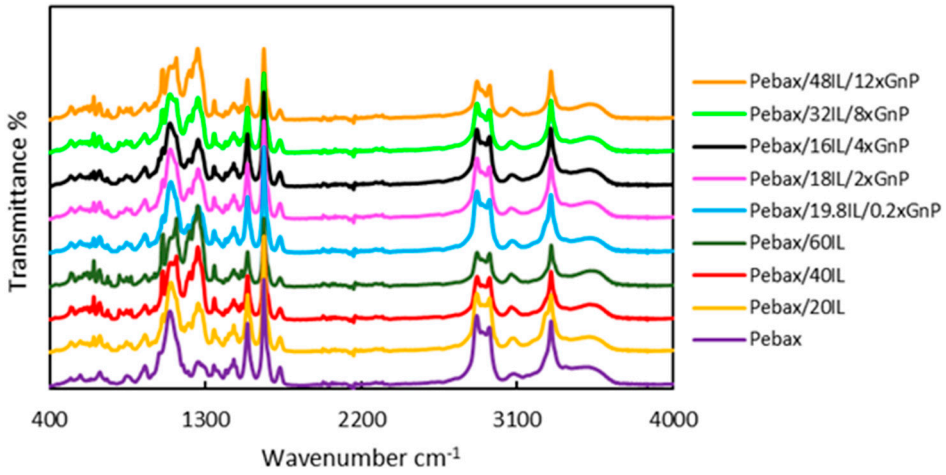


Figure S2. FTIR spectra of Pebax, Pebax/20IL, Pebax/40IL, Pebax/60IL, Pebax/19.8/IL/0.2xGnP, Pebax/18IL/2xGnP, Pebax/16IL/4xGnP, Pebax/32/8xGnP, and Pebax/48IL/12xGnP (full names in Table 1)

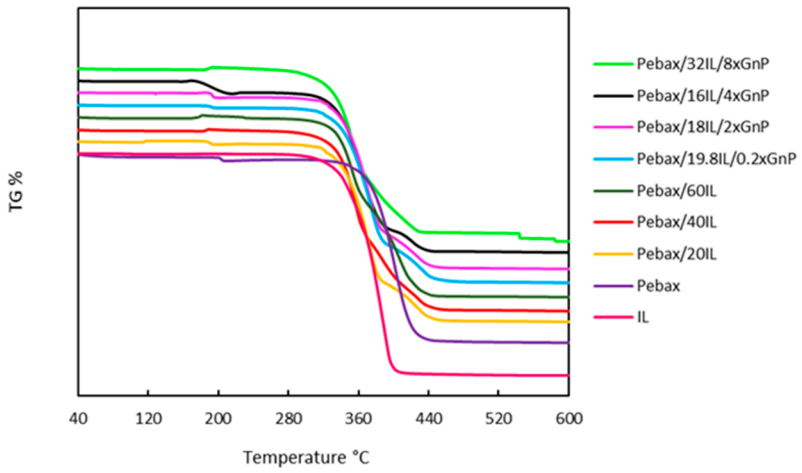


Figure S3. TGA Curves of IL, Pebax, Pebax/20IL, Pebax/40IL, Pebax/60IL, Pebax/19.8/IL/0.2xGnP, Pebax/18IL/2xGnP, Pebax/16IL/4xGnP, and Pebax/32/8xGnP (full names in Table 1).

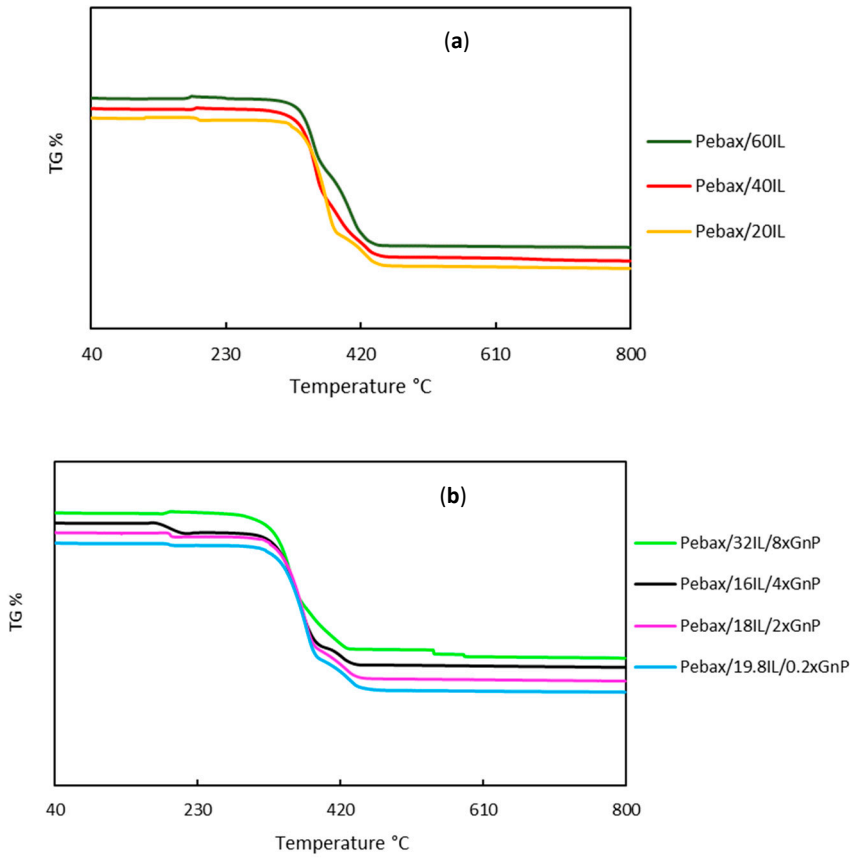


Figure S4. TGA Curves of a) CILPMs: Pebax/20IL, Pebax/40IL, and Pebax/60IL; and b) MMMs: Pebax/19.8/IL/0.2xGnP, Pebax/18IL/2xGnP, Pebax/16IL/4xGnP, and Pebax/32/8xGnP (full names in Table 1).

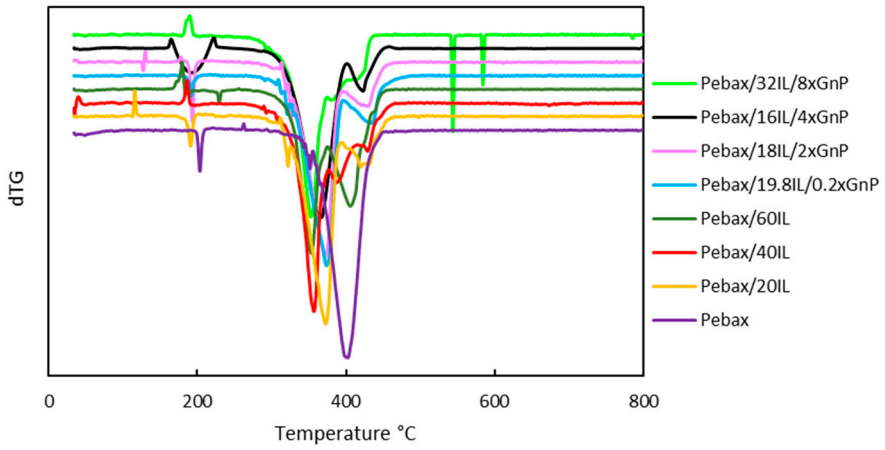


Figure S5. dTGA Curves of Pebax, Pebax/20IL, Pebax/40IL, Pebax/60IL, Pebax/19.8/IL/0.2xGnP, Pebax/18IL/2xGnP, Pebax/16IL/4xGnP, and Pebax/32/8xGnP (full names in Table 1).

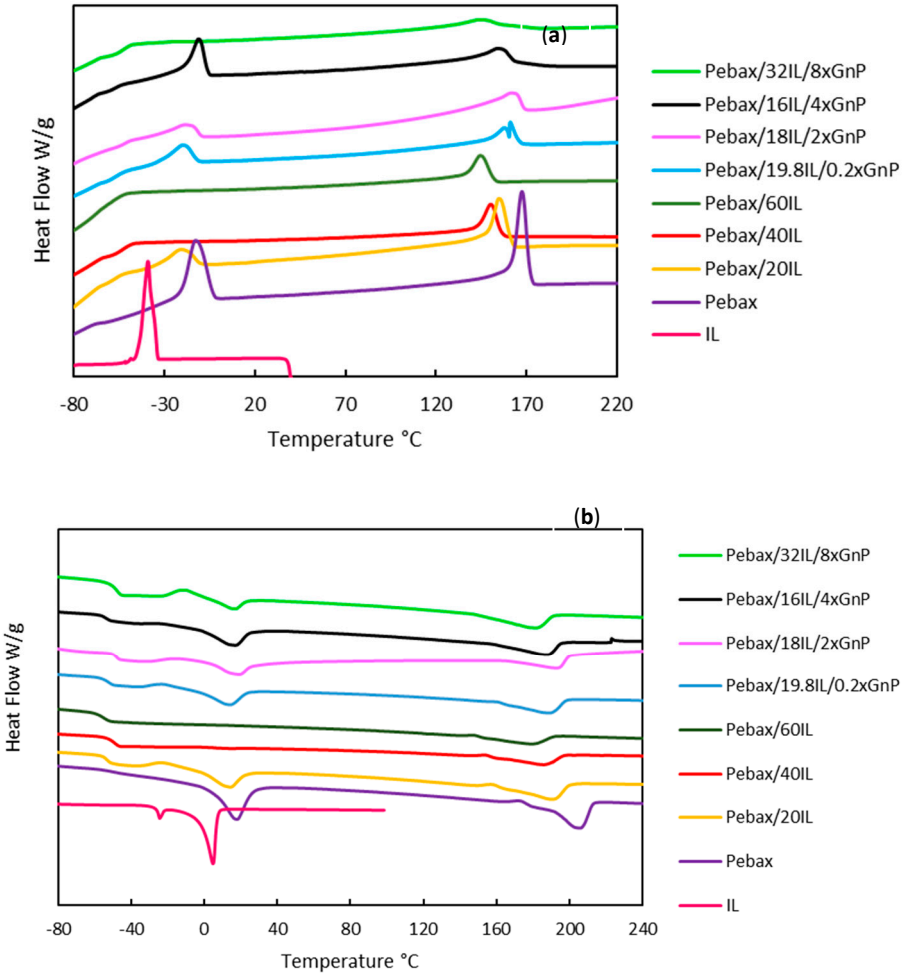
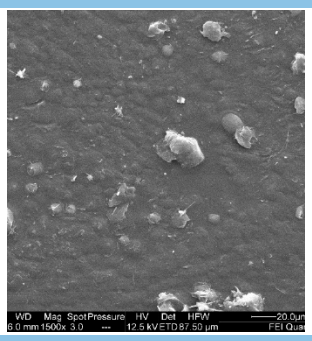
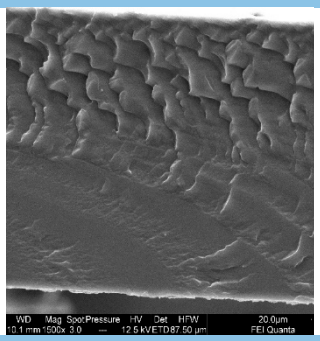
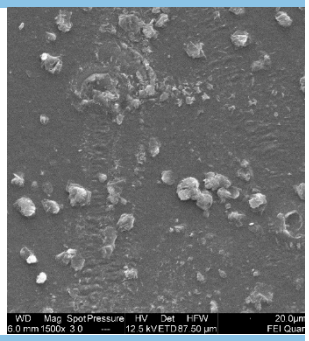
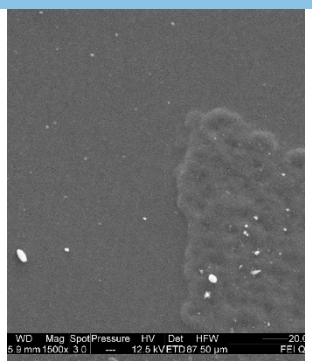
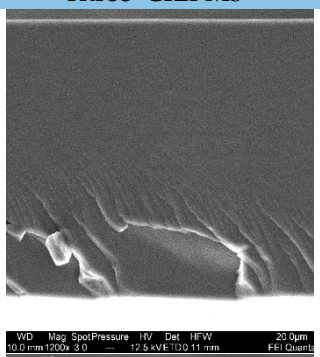
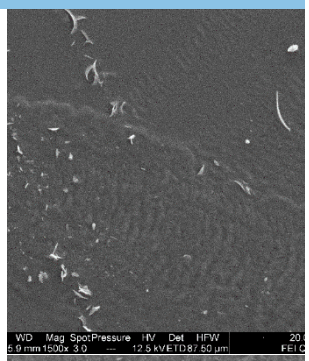
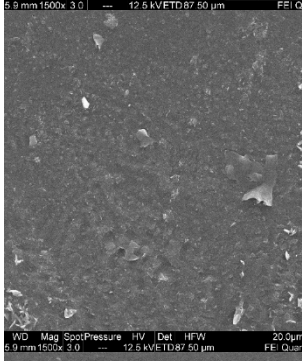
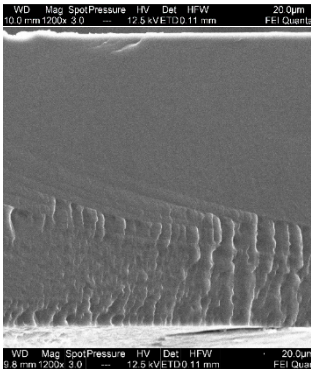
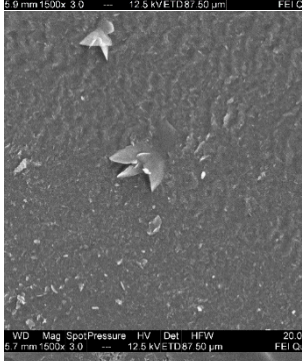
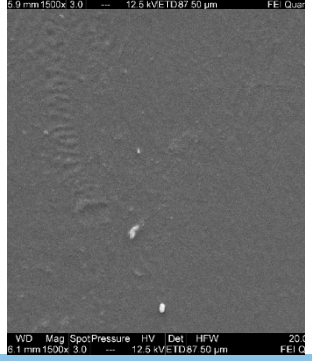
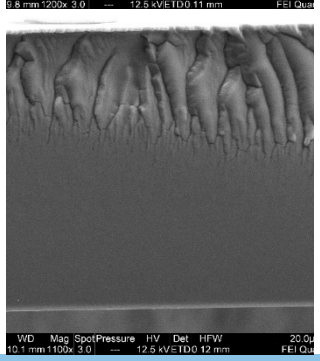
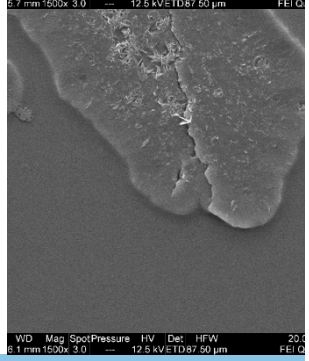
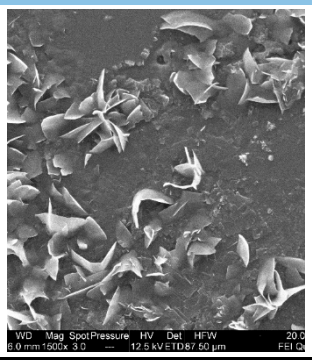
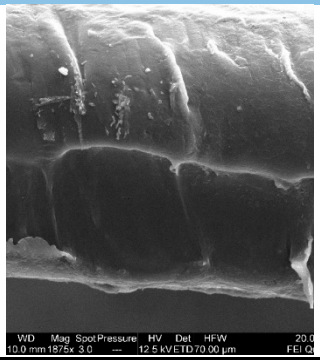
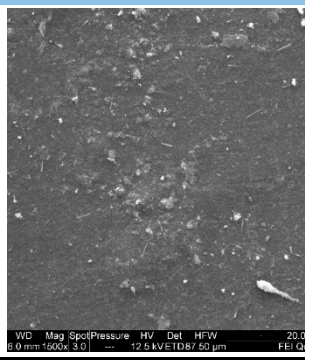


Figure S6. DSC Termograms of IL, Pebax, Pebax/20IL, Pebax/40IL, Pebax/60IL, Pebax/19.8/IL/0.2xGnP, Pebax/18IL/2xGnP, Pebax/16IL/4xGnP, and Pebax/32/8xGnP at 10°C/min: (a) cooling ramp, (b) heating ramp.

	Face up	*Cross Section*	*Face Down*
	Pure Pebax		
Pebax			
	Three CILPMs		
Pebax/20IL			
Pebax/40IL			
Pebax/60IL			
	Five MMMs		
Pebax/19.8IL/ 0.2xGnP			

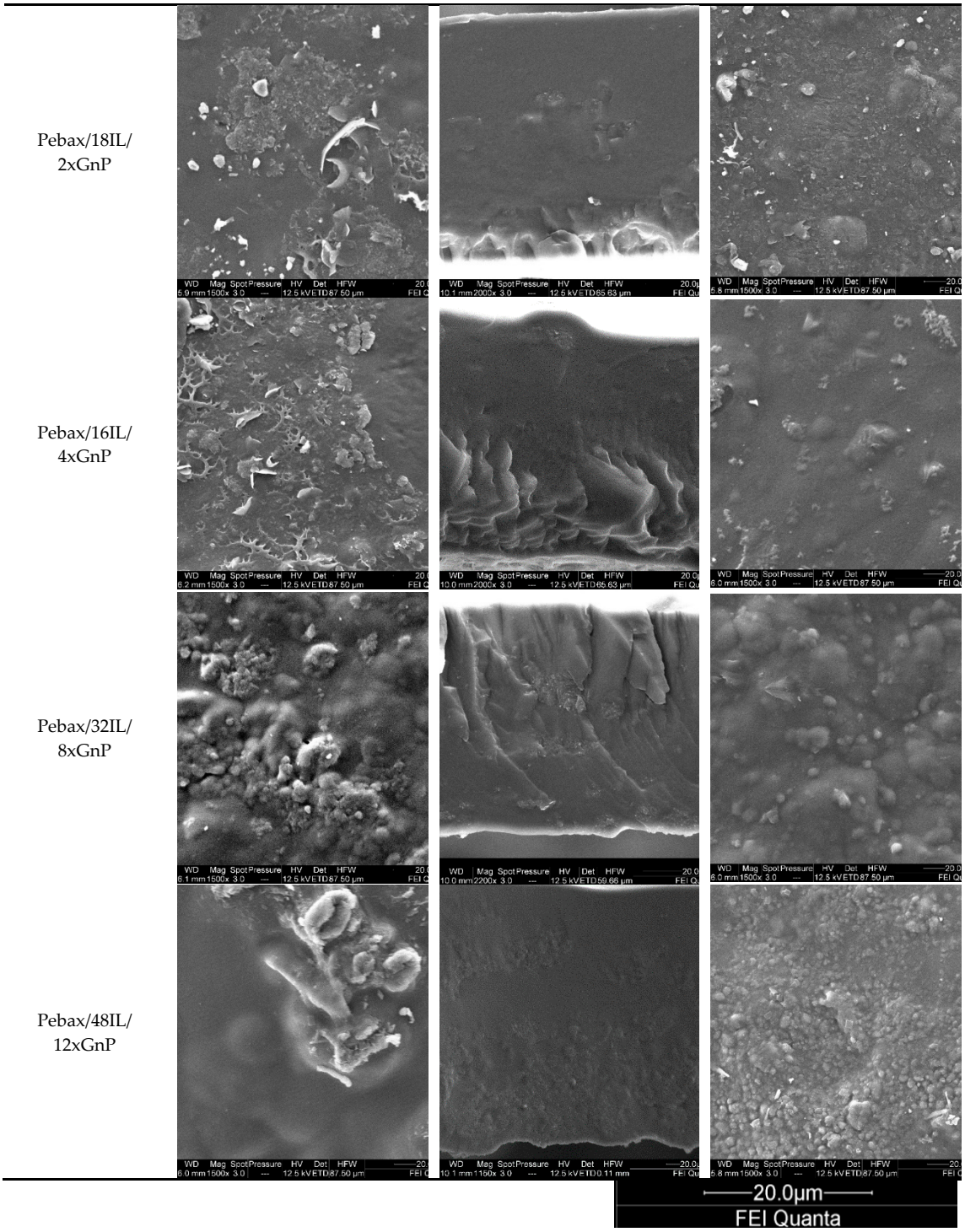


Figure S7. STEM images of Pebax, Pebax/20IL, Pebax/40IL, Pebax/60IL, Pebax/19.8IL/0.2xGnP, Pebax/18IL/2xGnP, Pebax/16IL/4xGnP, Pebax/32IL/8xGnP, and Pebax/48IL/12xGnP (full names in Table 1).

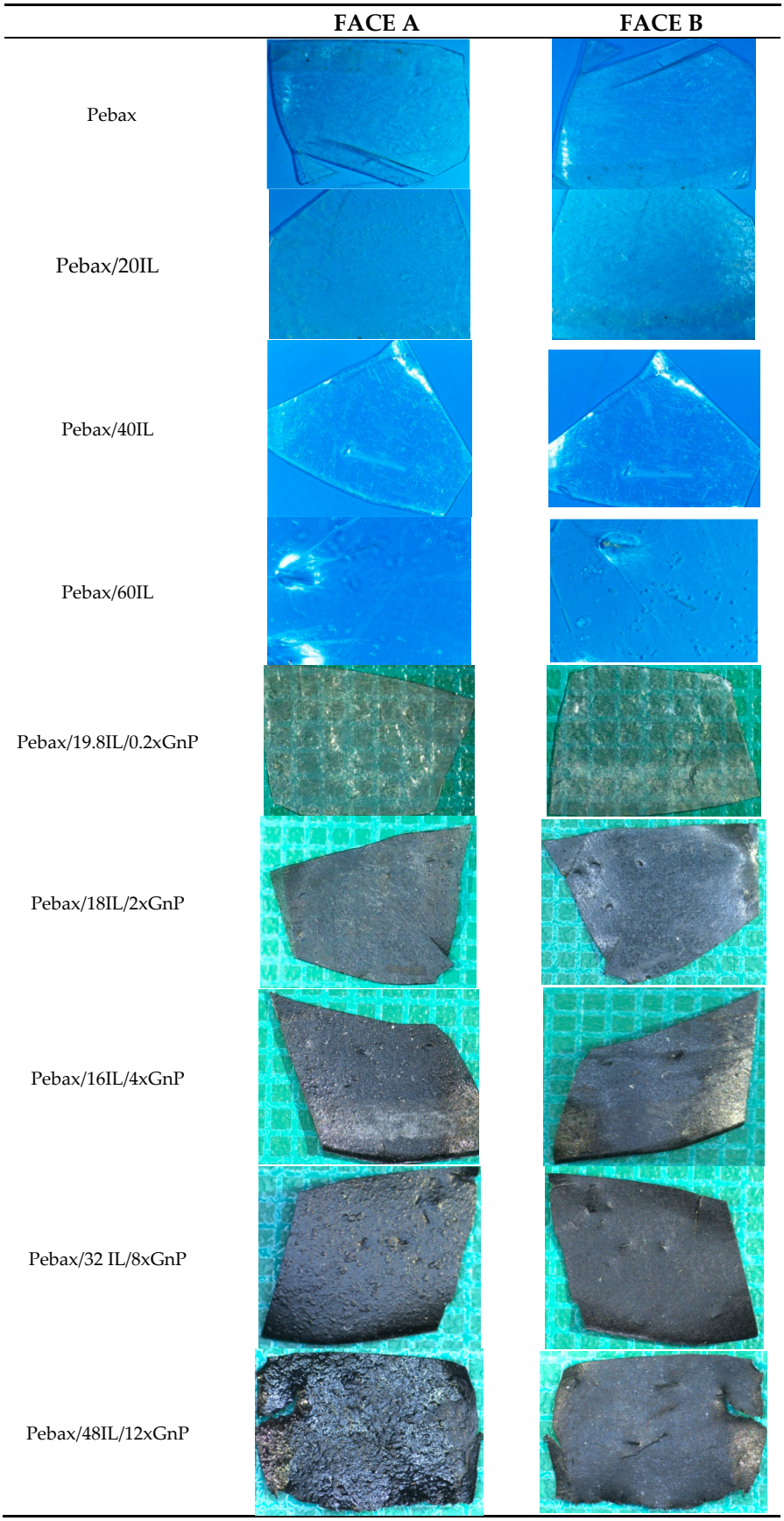
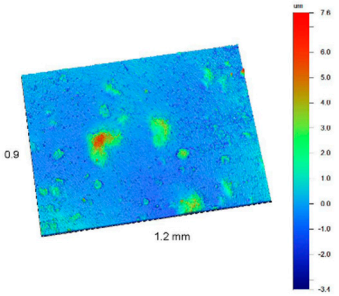
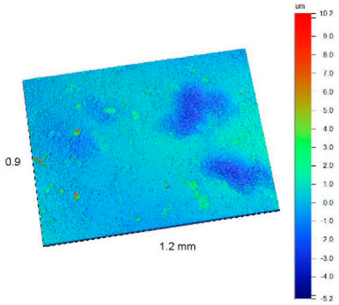
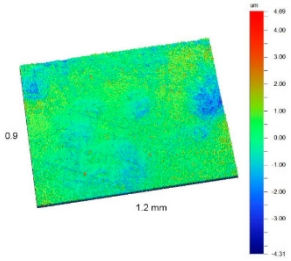
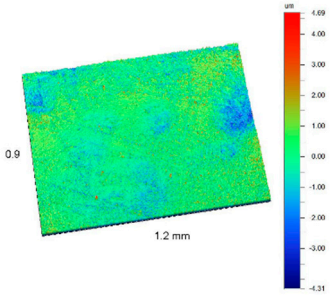
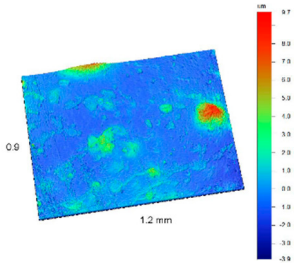
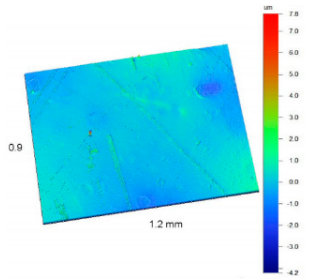
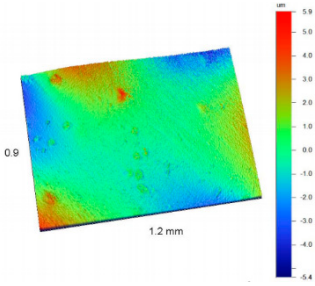
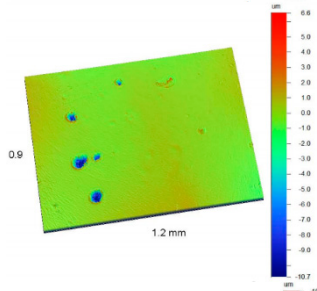
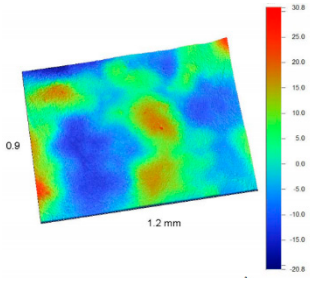
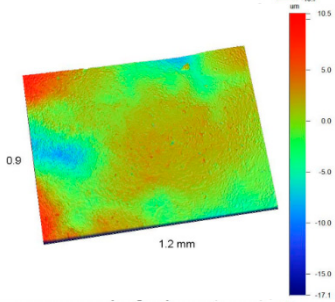
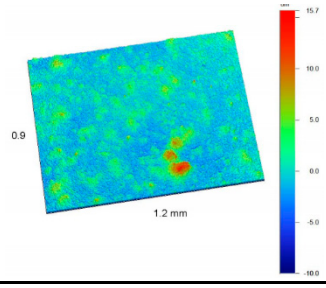
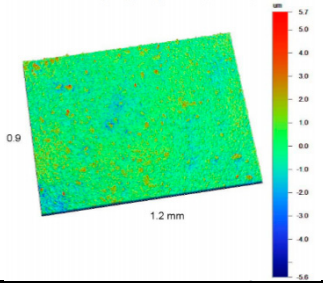


Figure S8. 2D imaging with optical reflection of Rough face A and face B of Pebax, Pebax/20IL, Pebax/40IL, Pebax/60IL, Pebax/19.8IL/0.2xGnP, Pebax/18IL/2xGnP, Pebax/16IL/4xGnP, Pebax/32IL/8xGnP, and Pebax/48IL/12xGnP (full names in Table 1).

	Rough face	Smooth face
Pebax		
Pebax/20IL		
Pebax/40IL		
Pebax/60IL		
Pebax/19.8IL/0.2xGnP		
Pebax/18IL/2xGnP		

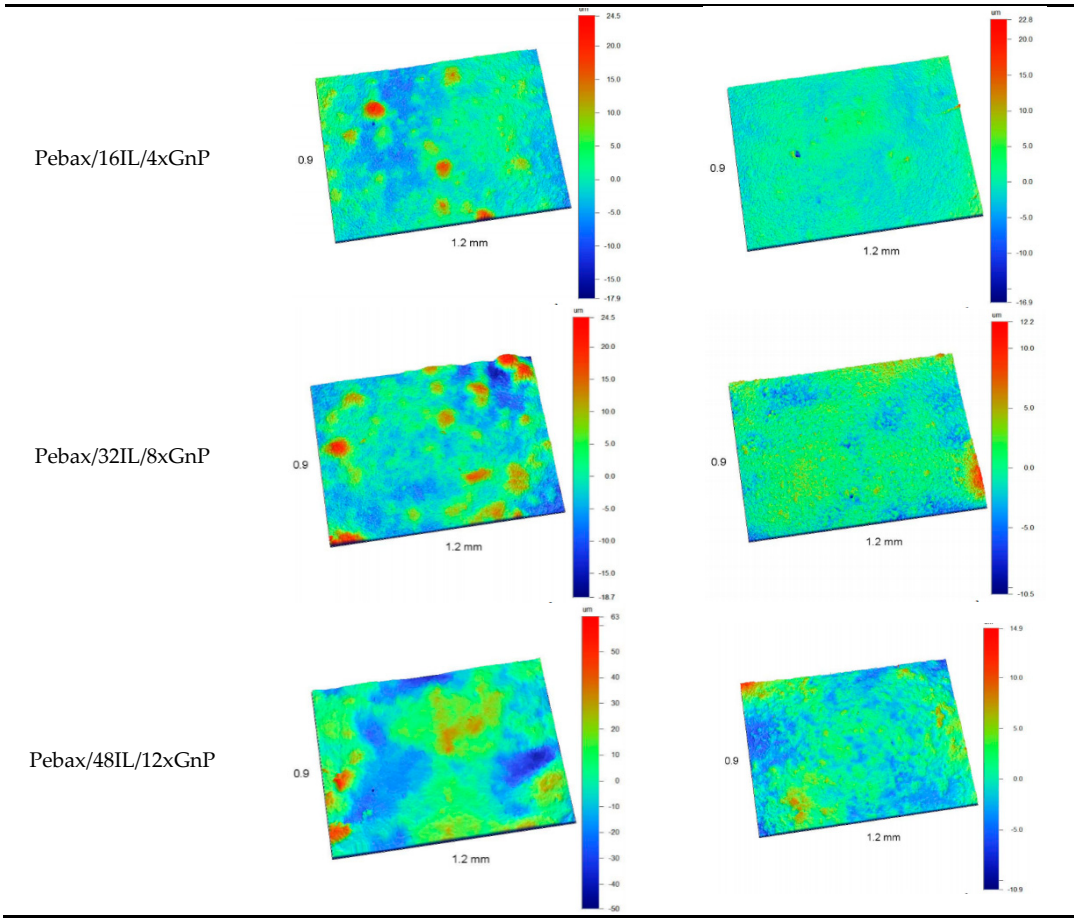


Figure S9. 3D imaging with topographic enhancement of Rough face and Smooth face of Pebax, Pebax/20IL, Pebax/40IL, Pebax/60IL, Pebax/19.8IL/0.2xGnP, Pebax/18IL/2xGnP, Pebax/16IL/4xGnP, Pebax/32IL/8xGnP, and Pebax/48IL/12xGnP (full names in Table 1).

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