

# Fabrication, Characterization, and Microbial Biodegradation of Transparent Nanodehydrated Bioplastic (NDB) Membranes Using Novel Casting, Dehydration, and Peeling Techniques

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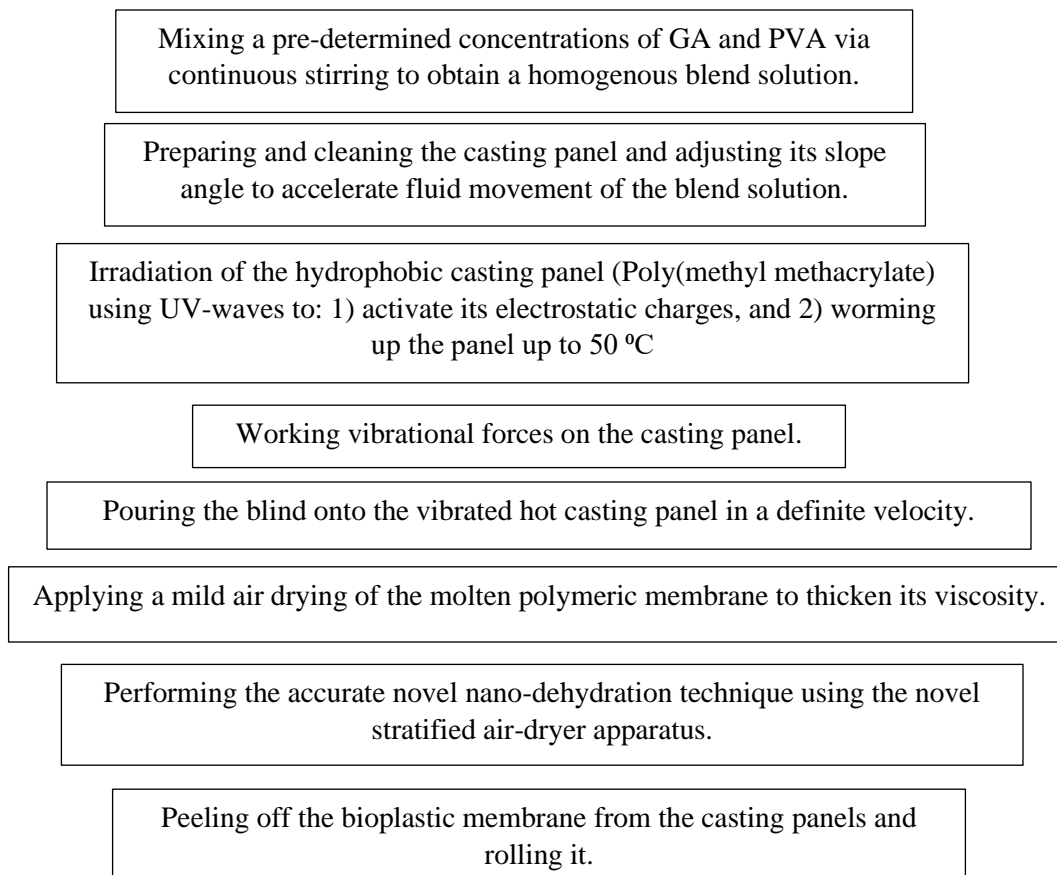
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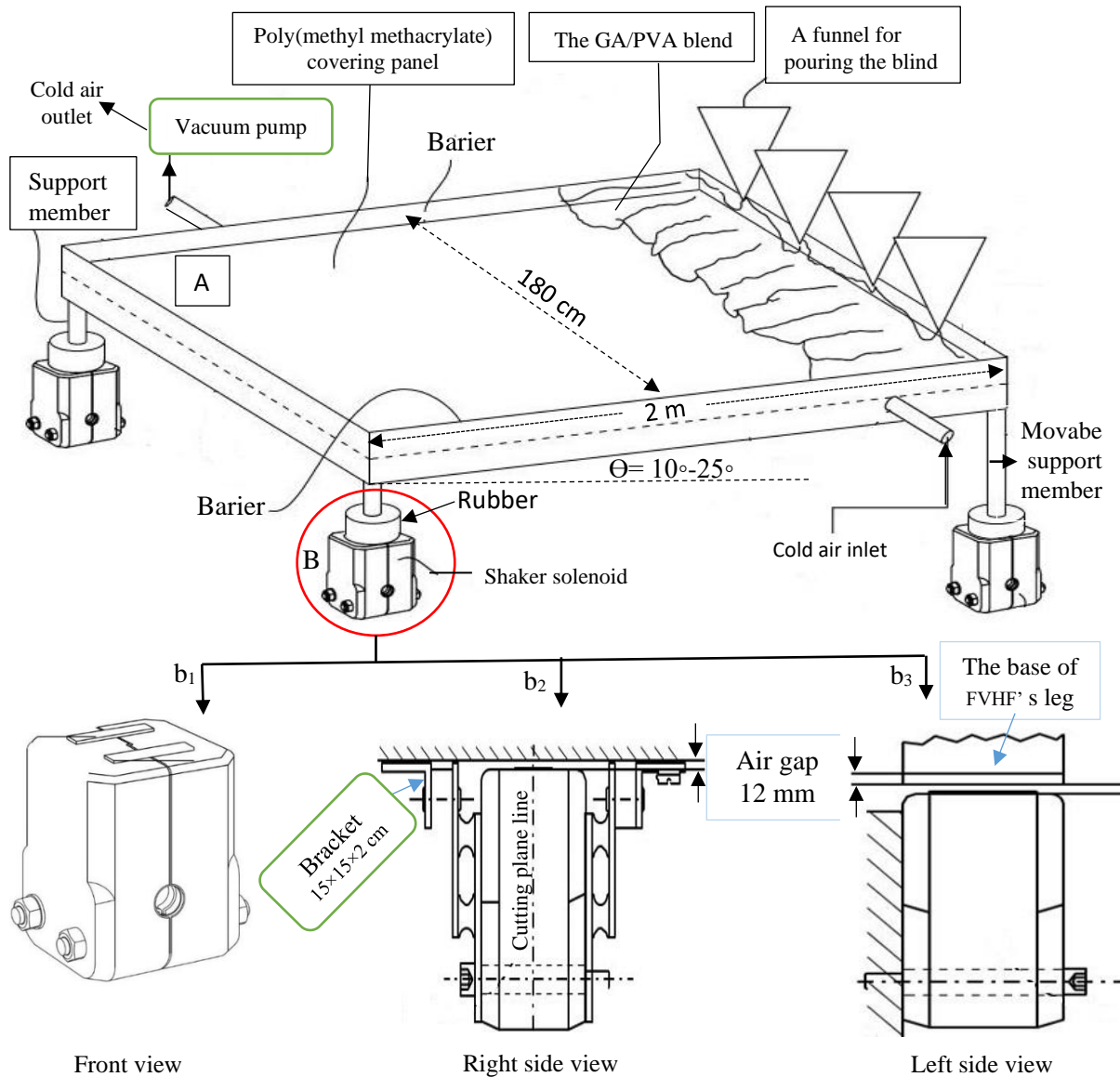
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**Section S1.** The casting technique steps



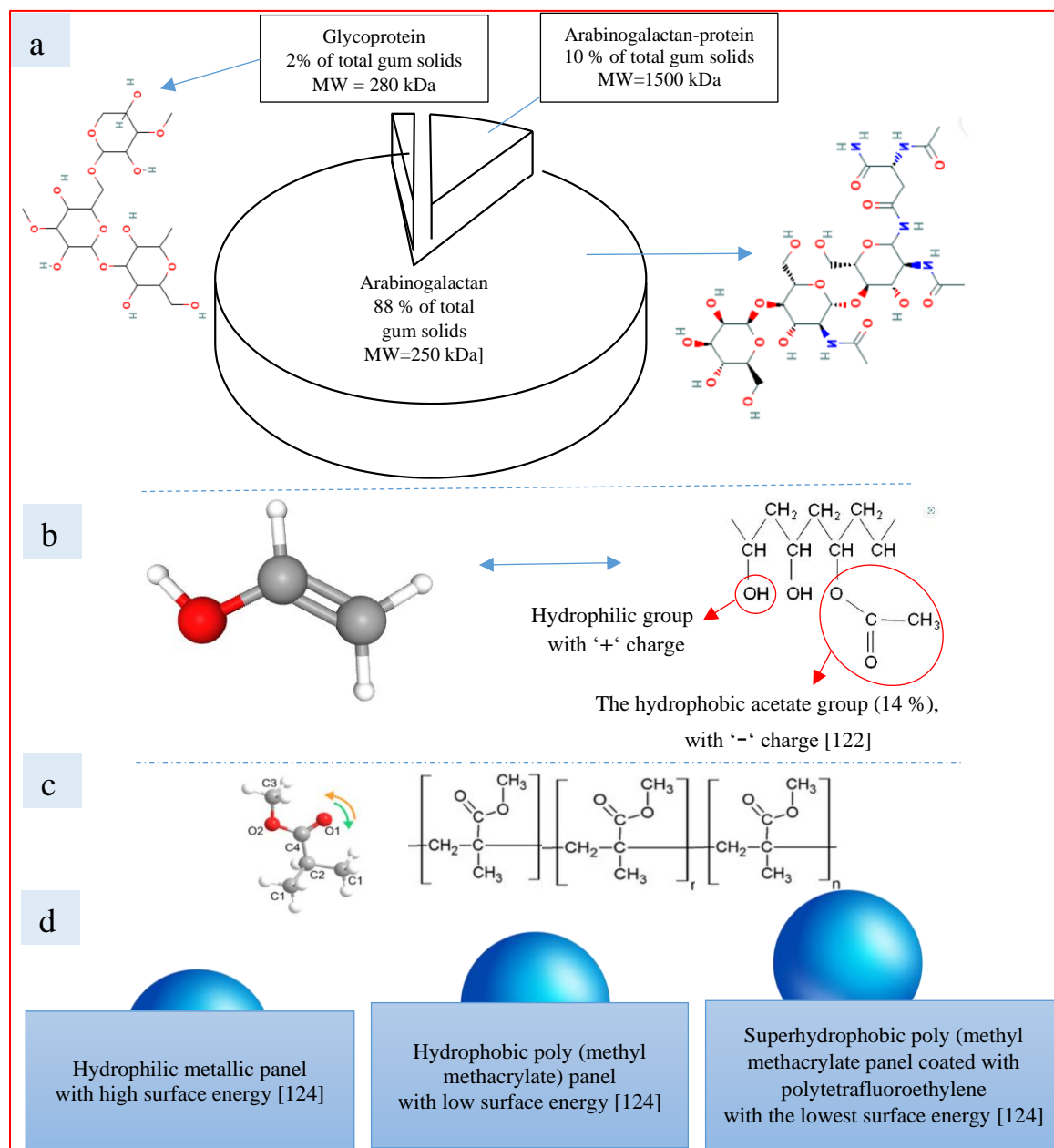
**Figure S1.** The practical procedure used for the novel casting of the bioplastic blends.

**Section S2.** The machinery of the novel casting method.



**Figure S2.** The casting process of the polymeric blends: A) the novel free vibrated-horizontal flow (FVHF) apparatus, and B) the magnetic vibrating system (shaker solenoid): b<sub>1</sub>) front view; b<sub>2</sub>) right side view showing the operational air gap (12 mm, thickness); b<sub>3</sub>) left side view [57].

**Section S3.** Chemophysical features of the polymers used in the bioplastic fabrication.



**Figure S3.** Chemical and physical features of the polymers used in manufacturing the NDB- membranes:  
a) gum Arabic (GA) precursor, b) polyvinyl alcohol (PVA) precursor, c) [poly(methyl methacrylate), PMMA] substrate [57.Hindi,Mona **2023**,93.Hindi et al 2017a, 114.Anonymous<sup>e</sup> 2023-115.Anonymous<sup>f</sup> 2023-116.Anonymous<sup>g</sup> 2023-117.Anonymous<sup>h</sup> 2023-118.Schmidt 1994, 122.Randall 1989].

**Section S4.** Wettability of different types of plastics.

**Table S1.** Surface energy and contact angle of the most important industrial polymers [[124.Elsabee 2012](#)].

Polymer abbreviation	Polymer name	Surface energy dynes/cm	Contact angle degree <sup>-1</sup>
PVA	Polyvinyl alcohol	37	10
Pes	Polyester	41	70
PS	Polystyrene	34	72
SAN	Styrene acrylonitrile	40	74
PC	Polycarbonate	46	75
PPO	Polyphenylene oxide	47	75
PET	Polyethylene terephthalate	42	76
PVDF	Polyvinylidene fluoride	25	80
ABS	Acrylonitrile butadiene styrene	35	82
PMMA	Poly (methyl methacrylate)	41	82
PI	Polyimide	40	83
PU	Polyurethane	38	85
PPS	Polyphenylene sulfide	38	87
PE	Polyethylene fluoride	30	88
PBT	Polybutylene terephthalate	32	88
PP	Polypropylene	30	88
PVCp	Polyvinyl chloride, plasticized	53	89
PES	Polyethersulfone	46	90
PVCr	Polyvinyl chloride, rigid	39	90
FEP	Fluorinated ethylene propylene	20	98
PDMS	Polydimethylsiloxane (silicone elastomer)	23	98
PTFE	Polytetrafluoroethylene	19	120
NR	Natural rubber	24	n.d.

n.d.: not defined.

**Section S5. Thermogravimetric analysis (TGA) nanodehydrated-bioplastic (NDM) membranes**

**Table S2.** Calculating <sup>1-3</sup> means <sup>4,5</sup> of mass loss (M<sub>L</sub>) of the NDB membranes blended from gum Arabic (GA) and polyvinyl alcohol (PVA) in the six ratios and different temperature zones (T-zones).

T-zones °C	Mass loss (%)					
	GA/PVA ratio					
	1:0	1:0.25	1:0.5	1:0.75	1:1	0:1
50°-100°	Iw <sup>6</sup> . 15.64	Iw. 9.62	Iw. 16.5	Iw. 15.95	Iw. 12.24	Iw. 12.99
	Fw <sup>7</sup> . 13.5	Fw. 9.18	Fw. 15.7	Fw. 15.15	Fw. 11.6	Fw. 12.25
	M <sub>L</sub> . 13.68	M <sub>L</sub> . 4.57	M <sub>L</sub> . 4.85	M <sub>L</sub> . 5.02	M <sub>L</sub> . 5.23	M <sub>L</sub> . 5.69
100°-150°	Iw. 13.5	Iw. 9.18	Iw. 15.7	Iw. 15.15	Iw. 11.6	Iw. 12.25
	Fw. 12	Fw. 8.6	Fw. 14.7	Fw. 14.1	Fw. 10.85	Fw. 11.15
	M <sub>L</sub> . 11.11	M <sub>L</sub> . 6.32	M <sub>L</sub> . 6.37	M <sub>L</sub> . 6.93	M <sub>L</sub> . 6.47	M <sub>L</sub> . 8.98
150°-200°	Iw. 12	Iw. 8.6	Iw. 14.7	Iw. 14.1	Iw. 10.85	Iw. 11.15
	Fw. 11.5	Fw. 8.18	Fw. 13.75	Fw. 13.5	Fw. 10.5	Fw. 10.25
	M <sub>L</sub> . 4.18	M <sub>L</sub> . 4.88	M <sub>L</sub> . 6.46	M <sub>L</sub> . 4.26	M <sub>L</sub> . 3.23	M <sub>L</sub> . 8.07
200°-250°	Iw. 11.5	Iw. 8.18	Iw. 13.75	Iw. 13.5	Iw. 10.5	Iw. 10.25
	Fw. 10.7	Fw. 7.64	Fw. 12.9	Fw. 13	Fw. 9.9	Fw. 9.85
	M <sub>L</sub> . 6.96	M <sub>L</sub> . 8.18	M <sub>L</sub> . 6.18	M <sub>L</sub> . 3.7	M <sub>L</sub> . 5.71	M <sub>L</sub> . 3.9
250°-300°	Iw. 10.7	Iw. 7.64	Iw. 12.9	Iw. 13	Iw. 9.9	Iw. 9.85
	Fw. 9.9	Fw. 6.5	Fw. 11.3	Fw. 11.6	Fw. 8.75	Fw. 8.85
	M <sub>L</sub> . 7.48	M <sub>L</sub> . 14.9	M <sub>L</sub> . 7.36	M <sub>L</sub> . 10.77	M <sub>L</sub> . 11.62	M <sub>L</sub> . 10.15
300°-350°	Iw. 9.9	Iw. 6.5	Iw. 11.3	Iw. 11.6	Iw. 8.75	Iw. 8.85
	Fw. 7.7	Fw. 5.68	Fw. 9.5	Fw. 9	Fw. 6.25	Fw. 7.25
	M <sub>L</sub> . 22.2	M <sub>L</sub> . 12.62	M <sub>L</sub> . 15.93	M <sub>L</sub> . 22.41	M <sub>L</sub> . 28.57	M <sub>L</sub> . 18.08
350°-400°	Iw. 7.7	Iw. 5.68	Iw. 9.5	Iw. 9	Iw. 6.25	Iw. 7.25
	Fw. 6.3	Fw. 4.48	Fw. 7	Fw. 6	Fw. 4.1	Fw. 4.05
	M <sub>L</sub> . 18.2	M <sub>L</sub> . 21.13	M <sub>L</sub> . 26.32	M <sub>L</sub> . 33.3	M <sub>L</sub> . 34.4	M <sub>L</sub> . 44.14
400°-450°	Iw. 6.3	Iw. 4.48	Iw. 7	Iw. 6	Iw. 4.1	Iw. 4.05
	Fw. 4.5	Fw. 3.24	Fw. 4.1 mg	Fw. 3.65	Fw. 2.2	Fw. 0.85
	M <sub>L</sub> . 28.6	M <sub>L</sub> . 27.68	M <sub>L</sub> . 41.43	M <sub>L</sub> . 39.17	M <sub>L</sub> . 46.34	M <sub>L</sub> . 79.01
450°-500°	Iw. 4.5	Iw. 3.24	Iw. 4.1	Iw. 3.65	Iw. 2.2	Iw. 0.85
	Fw. 3.8	Fw. 2.64	Fw. 3.2	Fw. 2.75	Fw. 1.2	Fw. 0.35
	M <sub>L</sub> . 15.6	M <sub>L</sub> . 18.52	M <sub>L</sub> . 21.95	M <sub>L</sub> . 24.66	M <sub>L</sub> . 45.5	M <sub>L</sub> . 58.82

<sup>1</sup> Using the following formula: M<sub>L</sub>, % = [(Iw-Fw)/Iw]×100], where

<sup>2</sup> Initial starting weight per mg of the GABM sample.

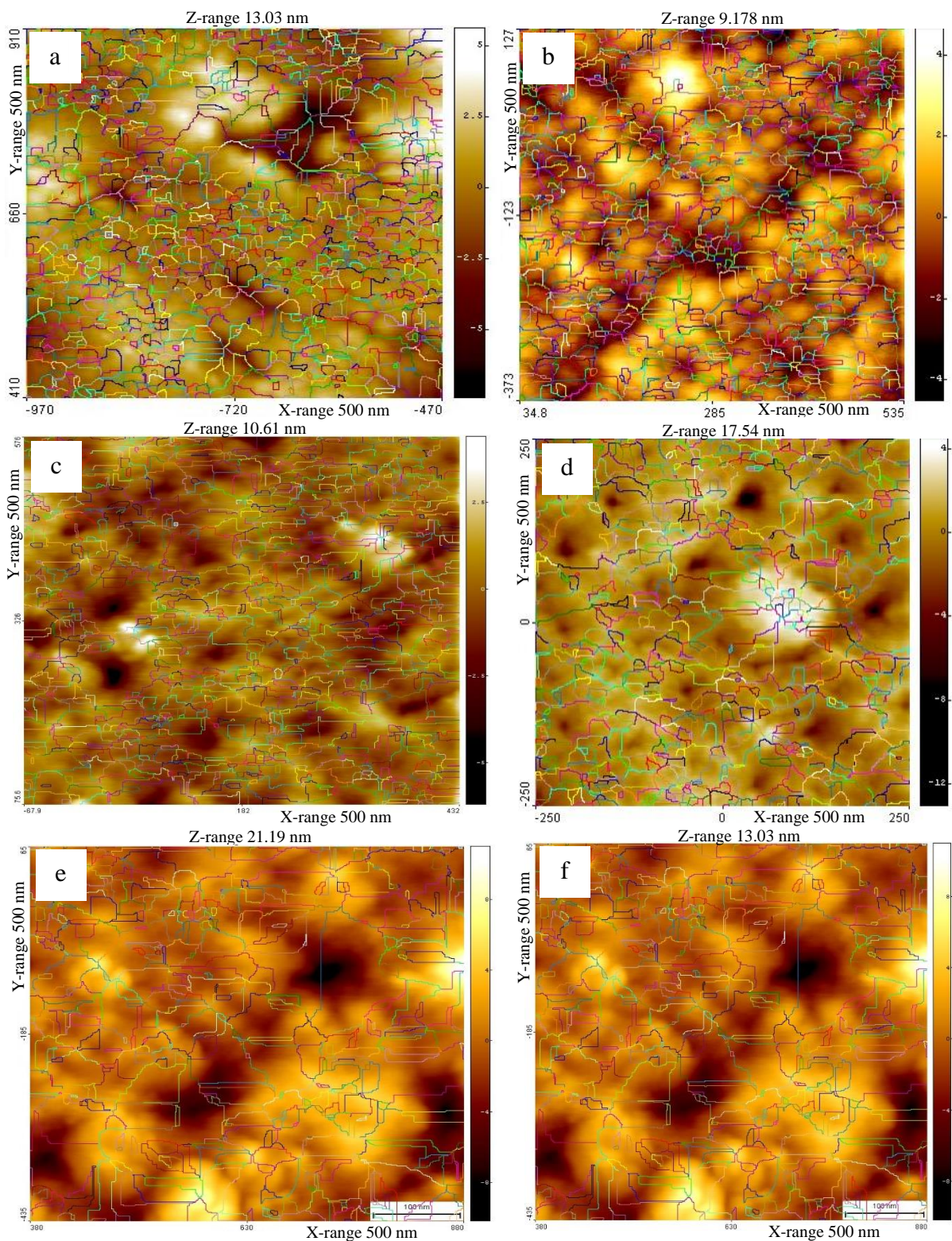
<sup>3</sup> Final starting weight per mg of the GABM sample.

<sup>4</sup> Each value is an average of 3 samples.

<sup>5</sup> Based on original oven-dry weight.



**Section S6.** Estimation of pore diameter of the bioplastic membranes.



**Figure S4.** Visualization analysis of pore diameter (PO) of the six nanodehydrated-bioplastic (NDB) membranes (NBMs): a) GA (100%), b) GA/PVA=1:0.25, c) GA/PVA=1:0.5, d), e) GA/PVA=1:0.75, and f) GA/PVA=1:1, and (PVA=100%) based on AFM-image analysis.