Supplemental Information

A solid-state growth of Ag nanowires and analysis of self-growing process on a bio-polymer chitosan film

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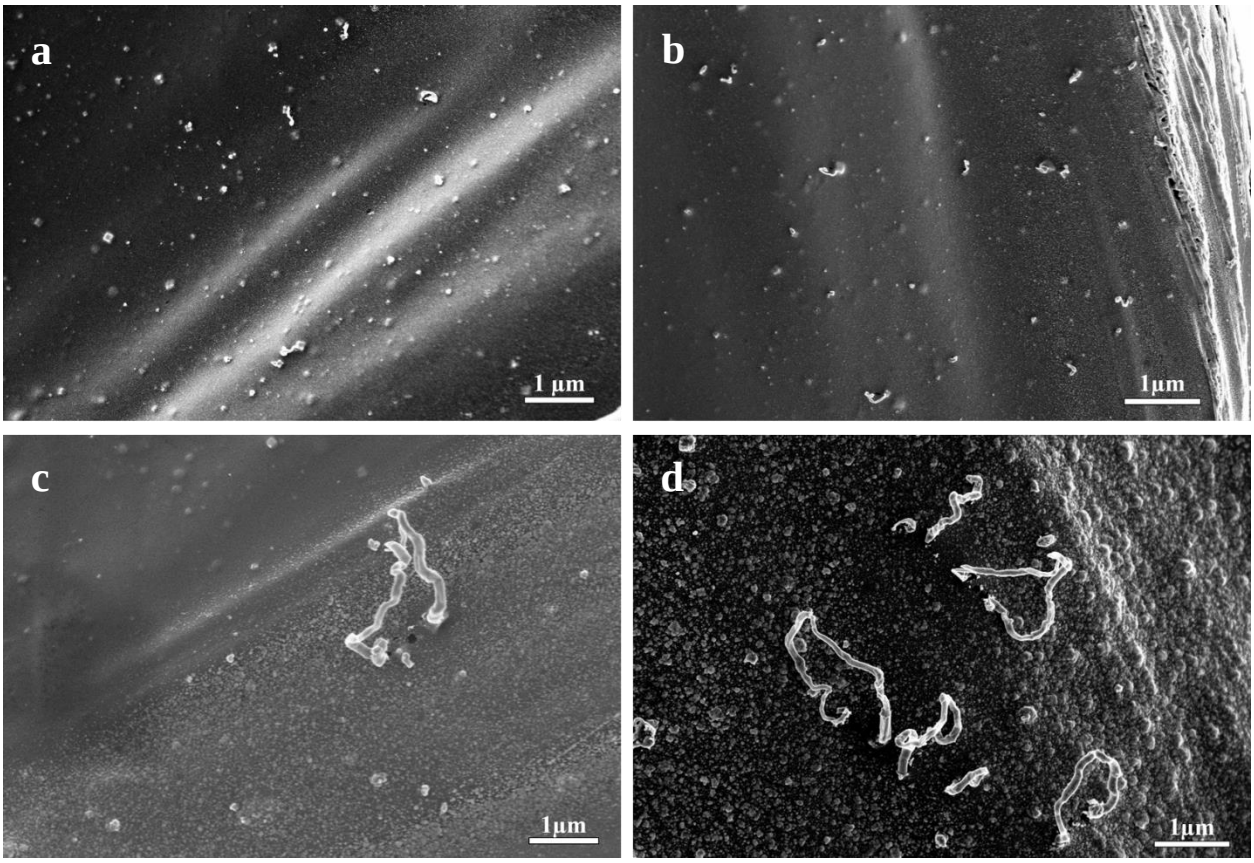

Figure S1: Growth of Ag NWs through the PVD coated Au thin film of 5nm thickness at random time slots as discussed for Au/Pd coated Ag film data in main article. a) & b) AgNWs growth on day 1 of the film at different locations. c) & d) AgNWs growth on week 1 of the film at different locations.

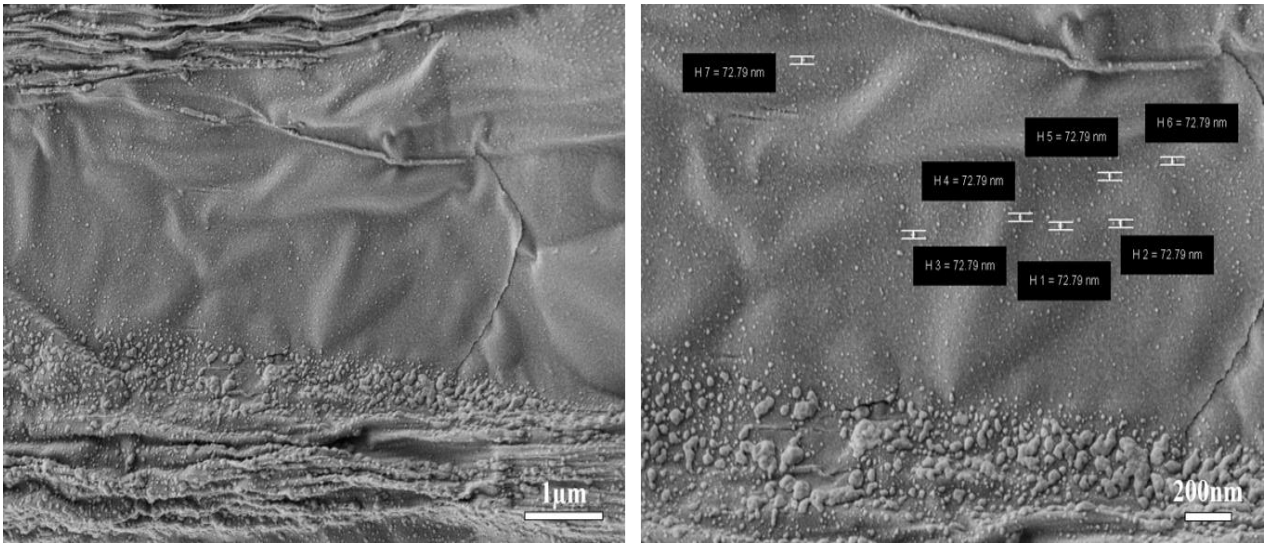

Figure S2: SEM images at different magnification of the Ag/Chitosan film prepared from Ag solution synthesized without NaCl. Film stored more than a week time, which is typical time required for Ag NWs to grow from film with NaCl inclusion. As discussed in main manuscript, AgNWs growth is not seen on these films.

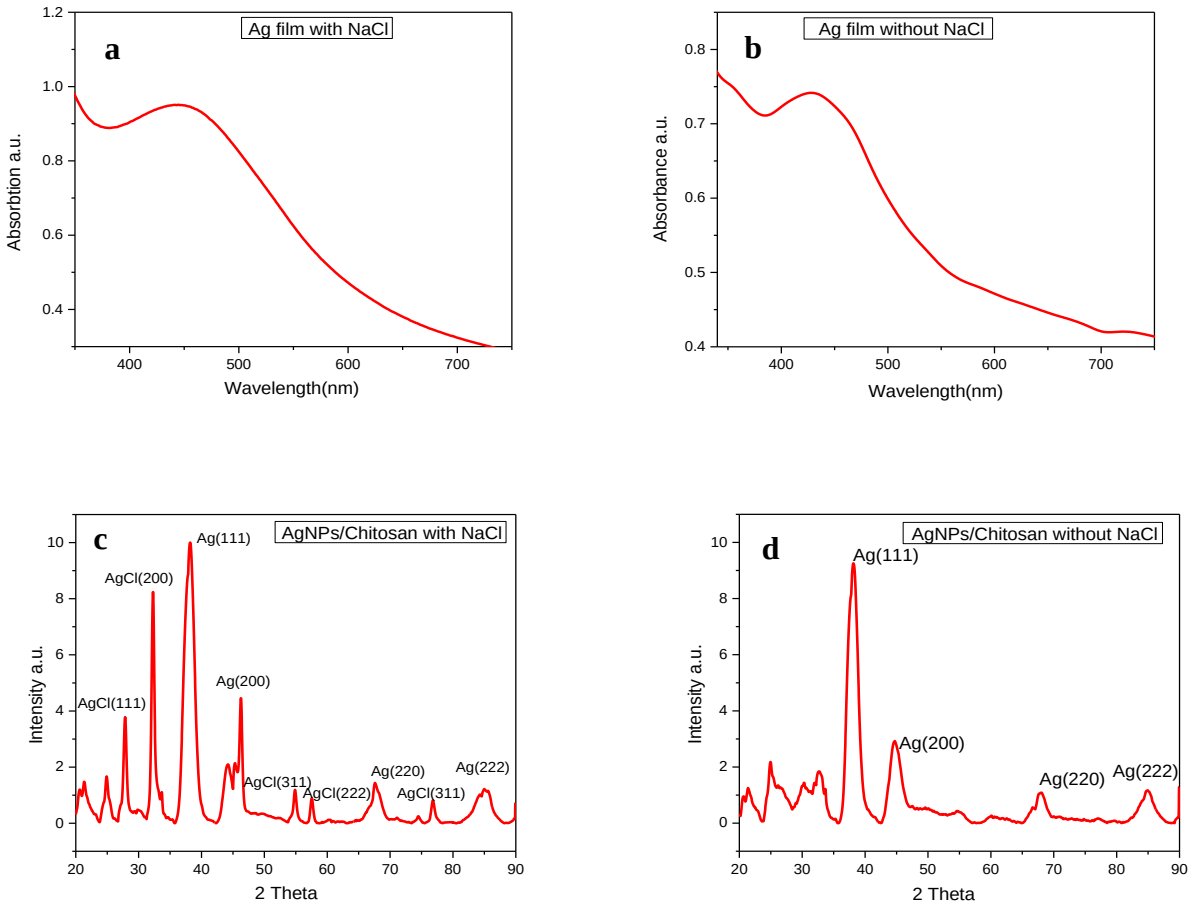

Figure S3: UV-Vis and XRD plots of with (Fig a and c) and without (Fig b and d) the addition of NaCl in the synthesis process to form Ag/Chitosan film.

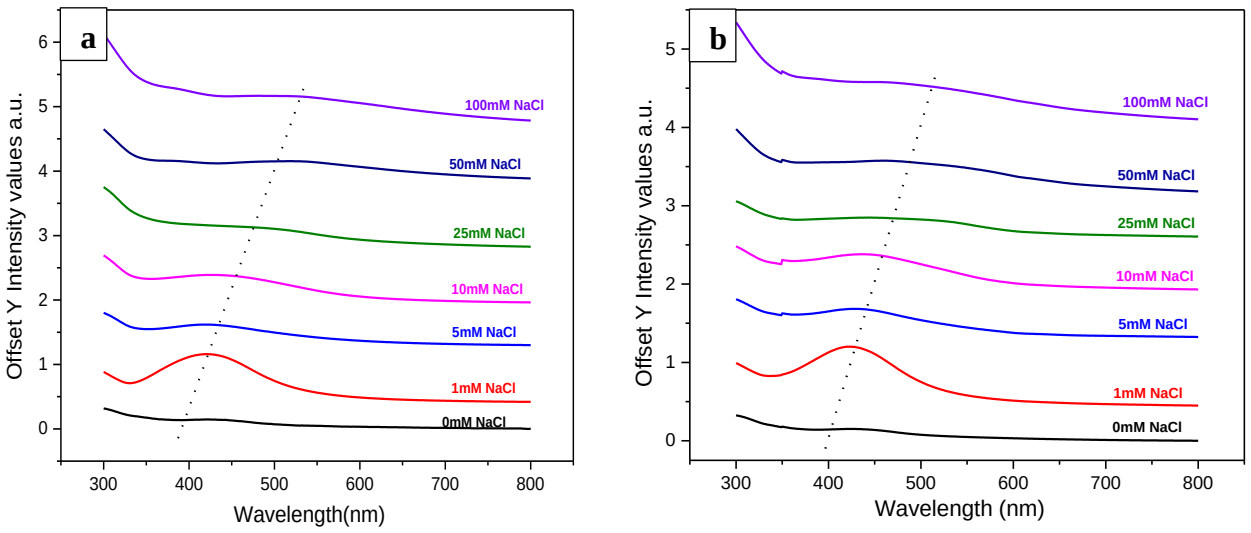

Figure S4: a. UV-Vis spectrum of Ag NPs solution with varying concentration of NaCl in the reaction process **b.** UV-Vis spectrum of Ag NWs films with varying concentration of NaCl.

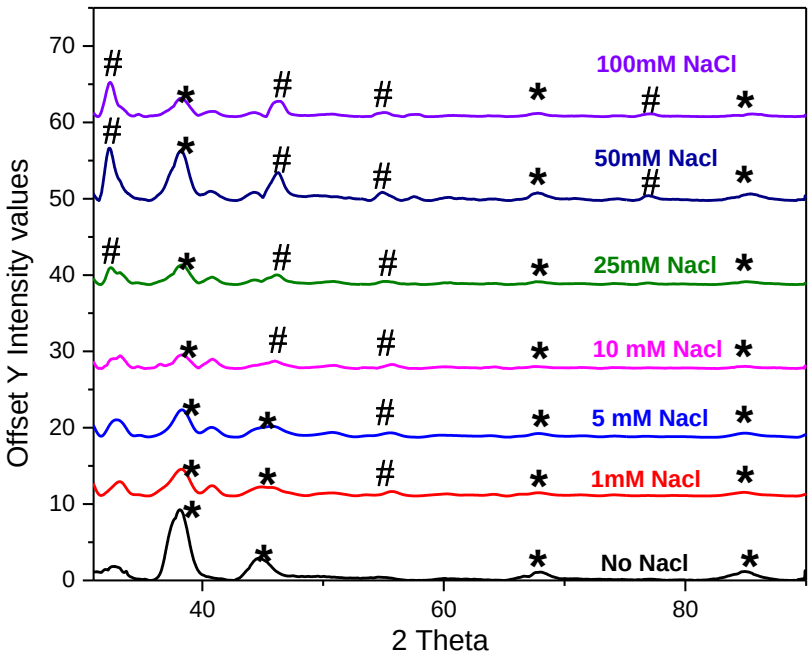

Figure S5: XRD plots of Ag/Chitosan films, starting with no NaCl addition film to gradual increase in NaCl concentrations as denoted. * represents Ag peaks and # represents AgCl peaks.

a

Mass percent (%)

Spectrum	C	N	O	Na	Cl	Pd	Ag	Au
Region 1	3.46	1.46	1.75	0.01	0.00	3.69	50.49	4.75
Region 2	0.00	0.83	1.59	0.00	0.00	4.97	54.48	6.41
Region 3	2.53	1.60	1.57	0.10	0.00	3.67	56.40	4.16
Region 4	2.29	1.35	1.87	0.00	0.00	4.48	45.35	5.99
Region 5	4.17	1.87	1.90	0.06	0.00	2.71	54.81	2.37
Region 6	2.26	1.16	1.99	0.02	0.00	5.44	44.21	7.22
Region 7	1.74	0.69	0.87	0.05	0.00	4.25	55.22	5.33
Region 8	2.92	1.01	1.07	0.00	0.00	4.63	52.91	5.62
Region 9	2.97	0.91	1.12	0.00	0.00	2.92	53.44	3.03
Region 10	5.30	2.11	2.28	0.02	0.00	2.72	52.98	2.42
Region 11	3.55	2.97	1.77	0.19	0.00	3.37	50.62	3.17
Region 12	4.33	2.89	1.69	0.10	0.00	4.80	46.29	5.80
Region 13	5.25	2.32	1.33	0.07	0.00	4.13	46.71	4.64
Region 14	3.04	2.42	1.32	0.08	0.00	4.42	48.17	5.27
Region 15	5.83	2.51	1.75	0.02	0.00	4.17	44.83	4.61
Region 16	5.14	2.11	1.03	0.10	0.00	4.08	50.03	4.59
Mean value:	3.42	1.76	1.56	0.05	0.00	4.03	50.43	4.71
Sigma:	1.54	0.74	0.40	0.05	0.00	0.80	4.07	1.41
Sigma mean:	0.39	0.19	0.10	0.01	0.00	0.20	1.02	0.35

b

Mass percent (%)

Spectrum	C	N	O	Na	Cl	Pd	Ag	Au
Region 1	12.15	-	5.63	2.41	1.39	4.33	18.79	5.81
Region 2	9.05	-	5.79	2.57	1.99	4.43	21.81	5.75
Region 3	12.54	-	5.80	2.32	1.03	5.00	17.05	6.92
Region 4	11.55	-	6.21	2.51	1.47	4.51	18.86	6.35
Region 5	14.13	-	6.01	2.29	1.07	5.07	16.42	7.06
Region 6	11.90	-	5.83	2.78	1.41	4.42	18.99	5.83
Region 7	10.38	4.00	7.39	2.24	1.55	3.67	18.05	4.82
Region 8	6.86	3.04	5.27	2.56	2.08	4.69	20.63	5.74
Region 9	9.33	4.54	7.96	2.03	1.21	4.41	15.47	6.18
Region 10	8.69	4.19	7.44	2.73	1.73	2.69	21.50	3.03
Region 11	7.71	3.95	6.82	2.69	1.58	3.84	19.97	5.21
Region 12	8.56	2.70	5.63	2.25	2.23	4.36	19.97	5.93
Mean value:	10.24	3.74	6.32	2.45	1.56	4.29	18.96	5.72
Sigma:	2.21	0.71	0.87	0.23	0.39	0.64	1.97	1.06
Sigma mean:	0.64	0.20	0.25	0.07	0.11	0.19	0.57	0.30

c

Mass percent (%)

Spectrum	C	N	O	Na	Cl	Pd	Ag	Au
Region 1	4.77	3.26	3.88	1.24	0.40	3.95	35.30	5.44
Region 2	3.48	2.75	3.12	1.00	0.10	4.41	40.07	5.98
Region 3	2.84	2.74	3.58	1.12	0.33	5.21	37.45	6.96
Region 4	3.46	2.88	4.14	1.19	0.17	4.24	39.17	5.53
Region 5	4.03	3.04	3.49	1.67	0.68	4.78	35.68	6.03
Region 6	6.88	3.22	3.20	1.50	0.67	4.55	35.15	5.66
Region 7	5.15	3.40	3.81	1.66	0.56	4.48	34.99	5.20
Region 8	5.24	3.11	4.01	1.41	0.68	4.91	34.77	6.14
Region 9	4.71	3.33	3.55	1.66	0.66	4.61	34.19	6.07
Region 10	3.94	3.16	3.40	1.81	0.56	4.12	35.80	5.37
Region 11	6.76	3.32	3.87	1.66	1.05	4.32	33.22	5.38
Region 12	5.19	3.02	3.48	1.40	2.49	4.99	33.63	6.11
Region 13	6.22	3.47	3.68	1.66	0.72	4.06	34.22	5.24
Region 14	5.56	3.18	3.09	1.63	0.31	3.90	35.77	4.85
Region 15	3.47	2.89	3.34	1.36	0.38	4.94	34.92	6.24
Mean value:	4.78	3.12	3.58	1.46	0.65	4.50	35.62	5.75
Sigma:	1.25	0.23	0.32	0.24	0.56	0.41	1.92	0.54
Sigma mean:	0.32	0.06	0.08	0.06	0.15	0.10	0.50	0.14

d

Mass percent (%)

Spectrum	C	N	O	Na	Cl	Pd	Ag	Au
Region 1	2.42	0.52	0.58	0.22	0.00	5.01	59.73	5.60
Region 2	3.12	1.28	1.18	1.19	0.00	5.42	47.87	6.83
Region 3	2.41	0.71	0.45	1.10	0.11	5.68	57.71	6.31
Region 5	1.92	1.27	1.10	0.79	0.00	4.02	55.31	4.75
Region 6	1.89	0.55	0.61	0.21	0.00	4.41	56.63	5.42
Region 7	3.06	0.90	0.83	0.99	0.19	4.21	51.29	4.86
Region 8	2.47	0.96	0.03	1.42	0.51	5.73	61.32	5.83
Region 9	3.86	1.37	0.92	1.34	0.00	5.14	48.36	6.39
Region 10	2.82	1.32	0.75	1.57	0.27	5.07	53.95	5.38
Region 11	1.89	0.61	0.72	0.37	0.00	3.97	56.52	4.26
Region 12	2.78	1.06	0.42	1.27	0.34	5.57	56.56	6.87
Region 13	2.47	0.98	0.47	1.03	0.66	5.85	56.20	6.53
Region 14	1.82	0.74	0.28	0.63	0.00	4.18	56.95	5.01
Region 15	2.01	0.48	0.00	1.05	1.05	6.04	66.82	5.56
Region 16	2.10	0.48	0.24	0.91	0.41	5.41	64.15	5.79
Mean value:	2.47	0.88	0.57	0.94	0.24	5.05	56.63	5.69
Sigma:	0.58	0.32	0.36	0.42	0.31	0.71	5.18	0.78
Sigma mean:	0.15	0.08	0.09	0.11	0.08	0.18	1.34	0.20

Figure S6: EDS mass percentage data of Ag films without and with NaCl. Raw data of mass percentage of elements on the films without and with NaCl at different points on film. a). Raw data of EDS for Ag film without NaCl. b). Raw data of EDS for Ag film with NaCl at week 0. c). Raw data of EDS for Ag film with NaCl at week 1. d). Raw data of EDS for Ag film with NaCl at week 2.

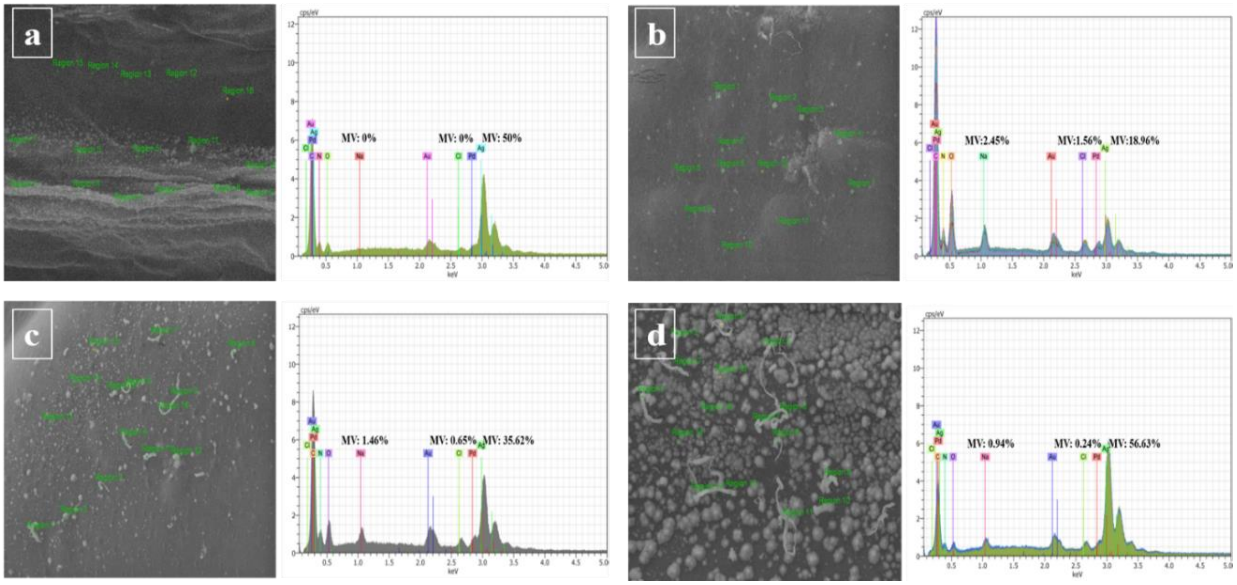

Figure S7: EDS analysis of Ag films without and with NaCl, comparing the elemental composition at different store times of the film. The green labels in SEM images show the regions of taking EDS spectra. a). Ag film without NaCl and its corresponding EDS. b). Ag film with NaCl at week 0 and its respective EDS. c). Ag film with NaCl at week 1 and its respective EDS. d). Ag film with NaCl at week 2 and its respective EDS.

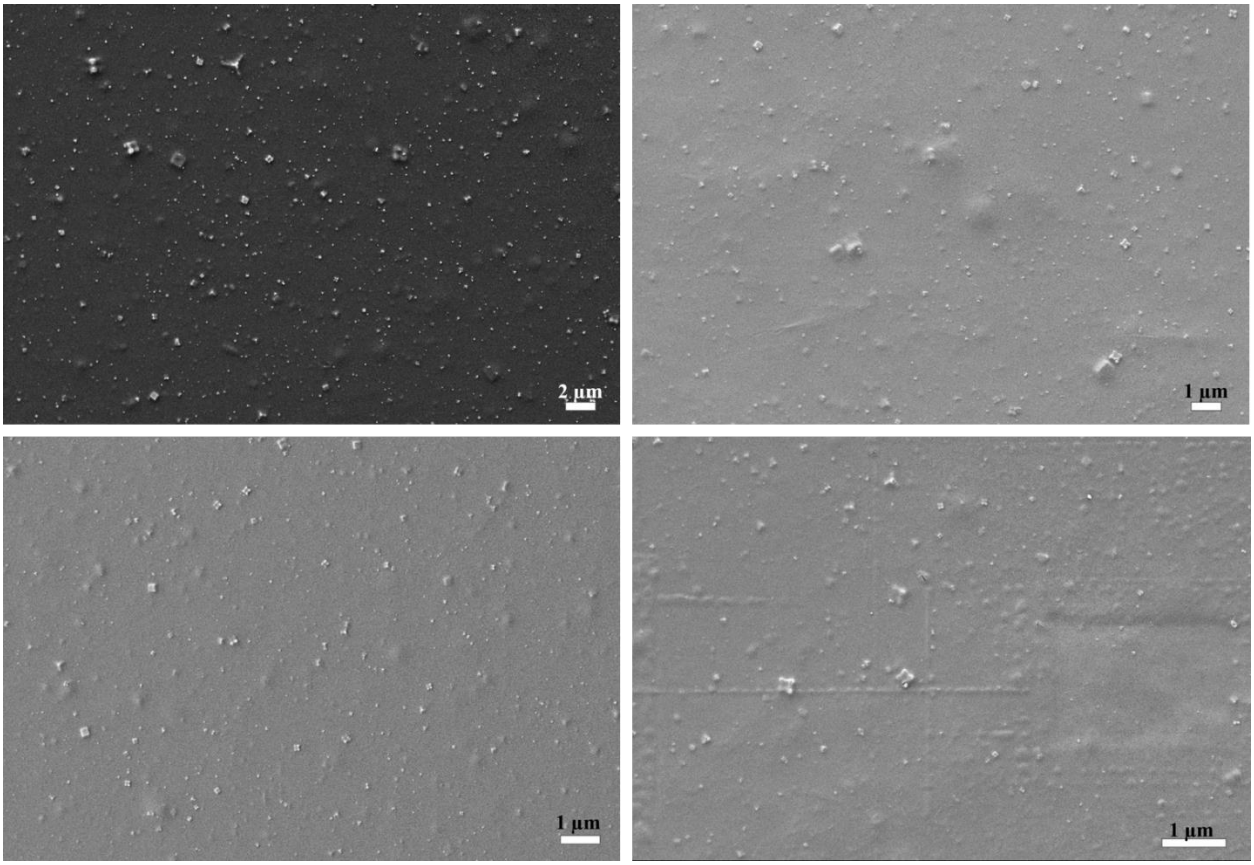

Figure S8: SEM image of Ag/Chitosan film at Week0. Four different locations on the same film

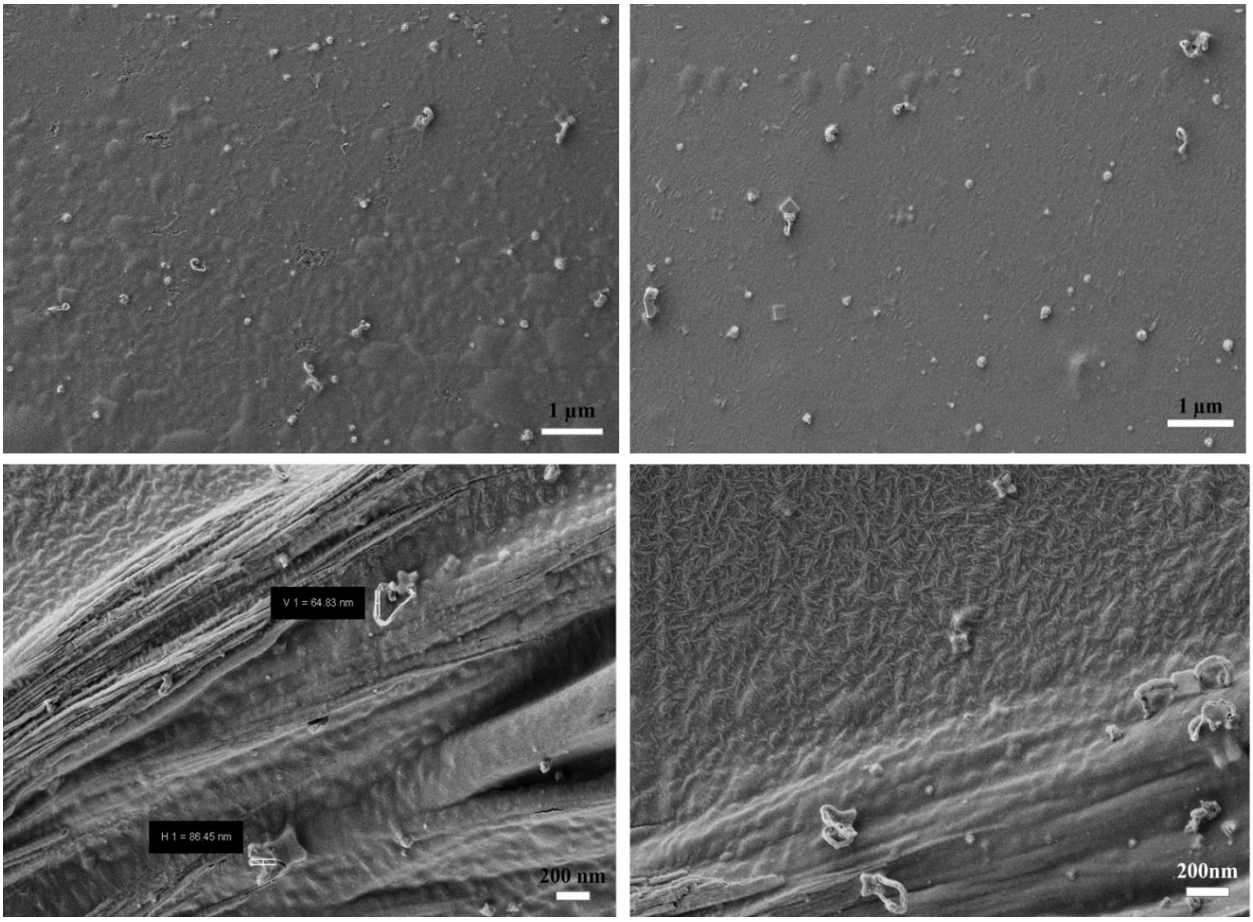

Figure S9: SEM image of Ag/Chitosan film at Week1. Four different locations on the same film

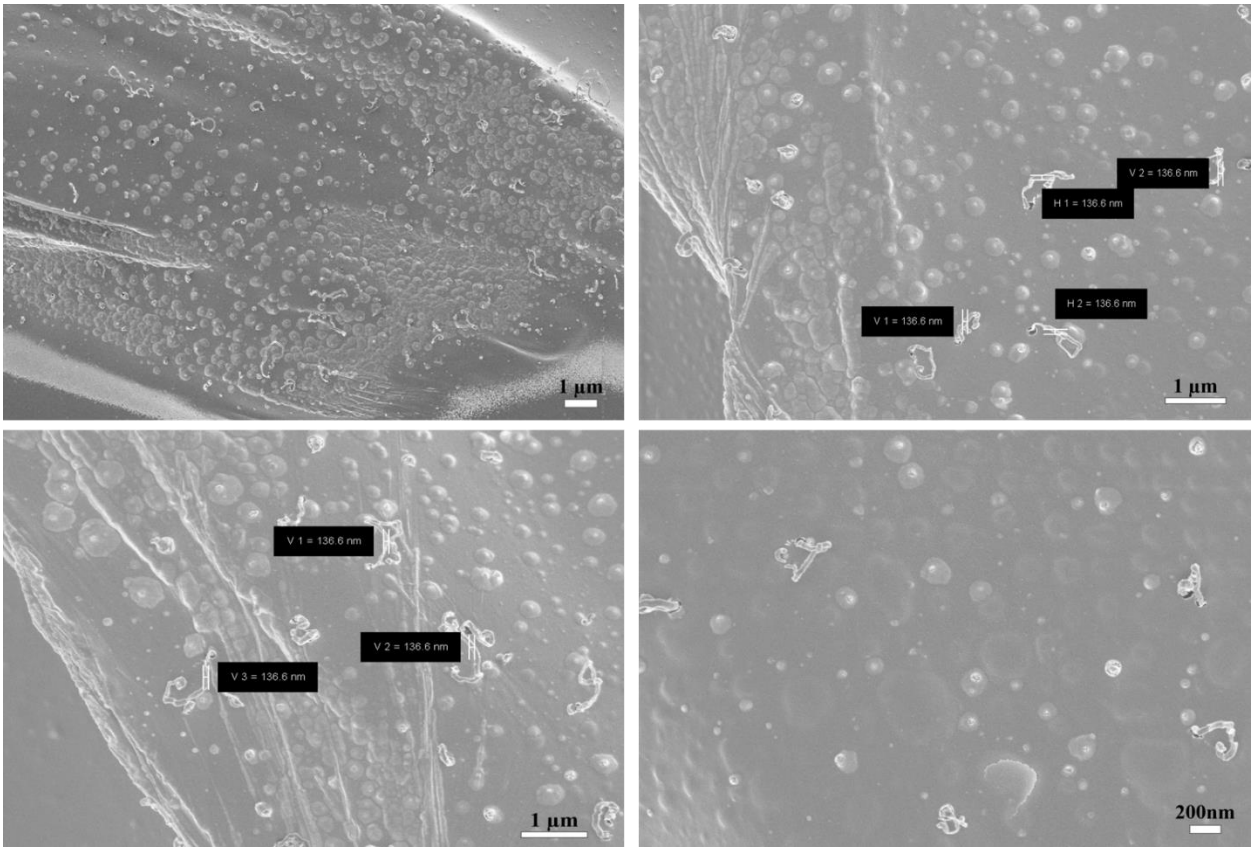

Figure S10: SEM images of Ag/Chitosan film at Week2. Four different locations on the same film

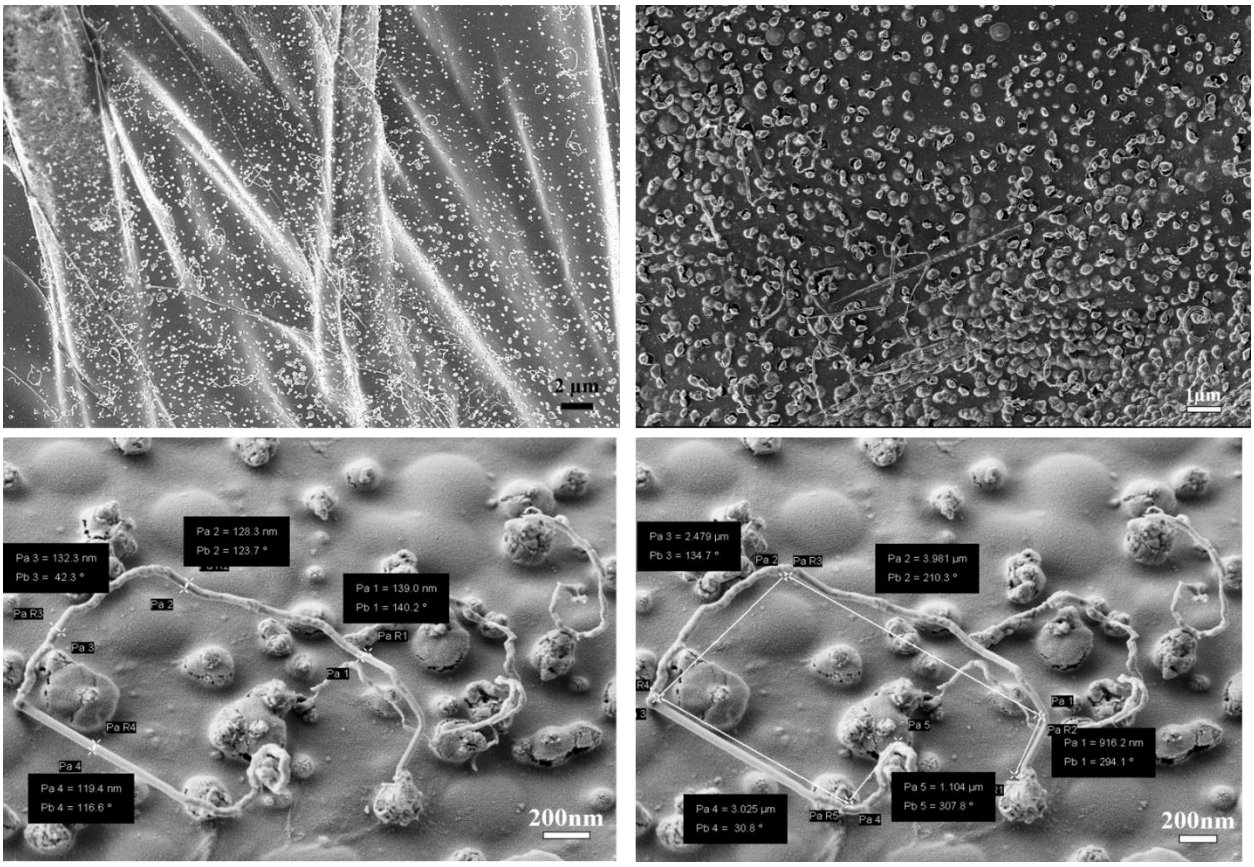

Figure S11: SEM images of Ag/Chitosan film at week4. Four different locations on the same film

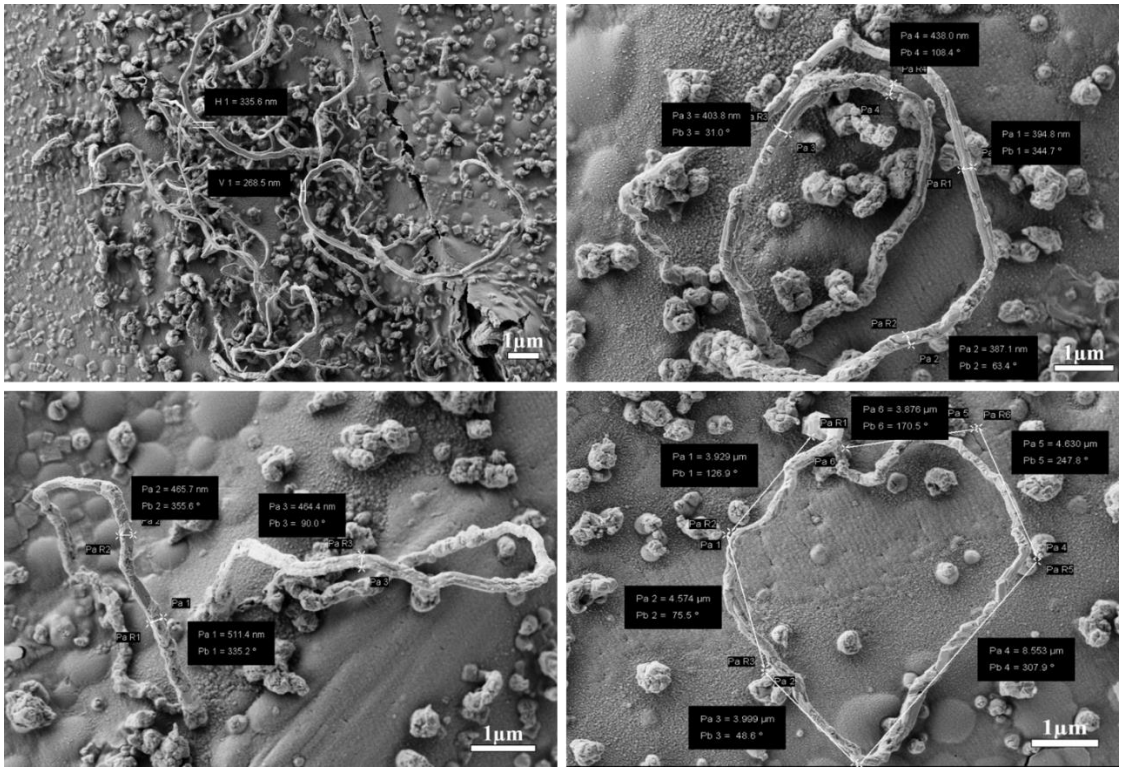

Figure S12: SEM images of Ag/Chitosan film at beyond week4. Four different locations on the same film

Table 1S: Comparison of Ag NW diameter and length with aging of film in # of weeks

Week0	Week1	Week2	Week4	Beyond Week4
Immediate SEM characterization after making film and coating with Au/Pd	SEM imaging during week1 of the film	SEM imaging during week2 of the film	SEM imaging during week4 of the film	SEM imaging after week4 of the film
Cubic structure	Ag NW of diameter 65nm±15nm	Ag NW of diameter 135nm±15nm	Ag NW of diameter 165nm±20nm	Ag NW of diameter 400nm±50nm
Cubic structure	Ag NW of length 500nm±50nm	Ag NW of length 4µm±1µm	Ag NW of length 9µm±1µm	Ag NW of length 28µm±2µm

To further clearly depict the Ag NWs growth width and length wise individually, SEM images of individual Ag NWs on the film were obtained, which show clear width change along the growth of Ag NWs (Figure S13-S14 respectively).

Figure S13 represents the change in width of Ag NW along its growth process overtime. Figure S13a shows SEM image of single vertically grown Ag NW of width ~120 nm. Figure S13 b&c shows gradual change of wire width from growth root towards tip, starting from width of ~280 nm to ~50 nm for Figure S11b and from ~135 nm to ~50 nm for Figure S13c. Figure S13d shows fully grown single nanowire with uniform width ~200 nm of all of its grown length.

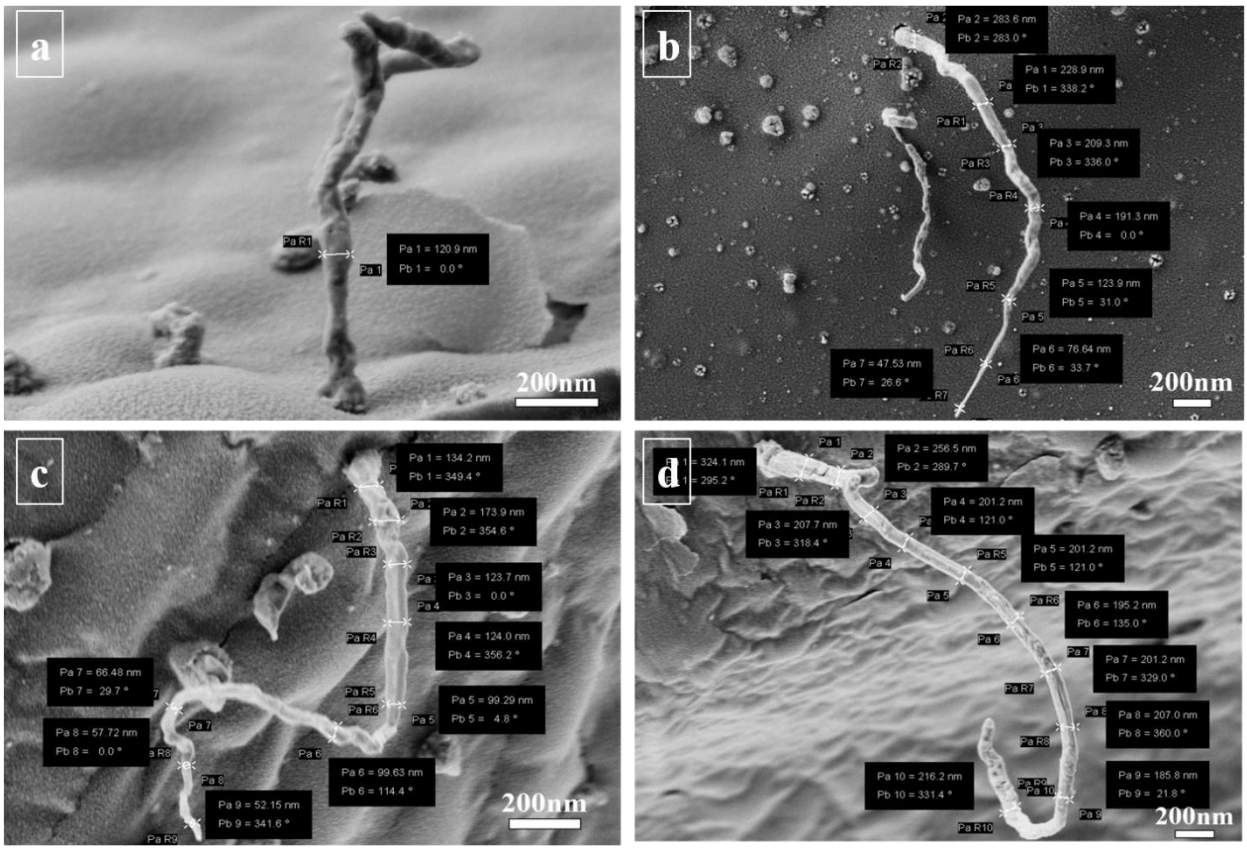

Figure S13: Growth progress with respect to width of Ag NW. a, b, c, and d represent Ag NWs on random Ag films representing growth progress and change in width of wire with growth progress of the same.

Figure S14 presents SEM images of stage wise growth of Ag NWs in its length. It can be clearly observed the step by step raise in Ag NW length w.r.t. the presented SEM images below ranging wire length from 0 nm to 20 µm of length. SEM images are taken on films with passing time in span of weeks. Figure S14a represents SEM image of the film on week 0, where just AgCl cubic structures are seen on the film. Figure S14b represents week 1, showing initial growth of the wire with minimal length of Ag NW. With passing of weeks/aging of the film, consuming the Ag source from the film it is seen in Figure S14c, d, e and f the raise in length of Ag NW linearly to the point

of ~20 µm. This dependence of Ag NW length w.r.t storing time of film is further represented in bar graph, presented in supplementary document image S14.

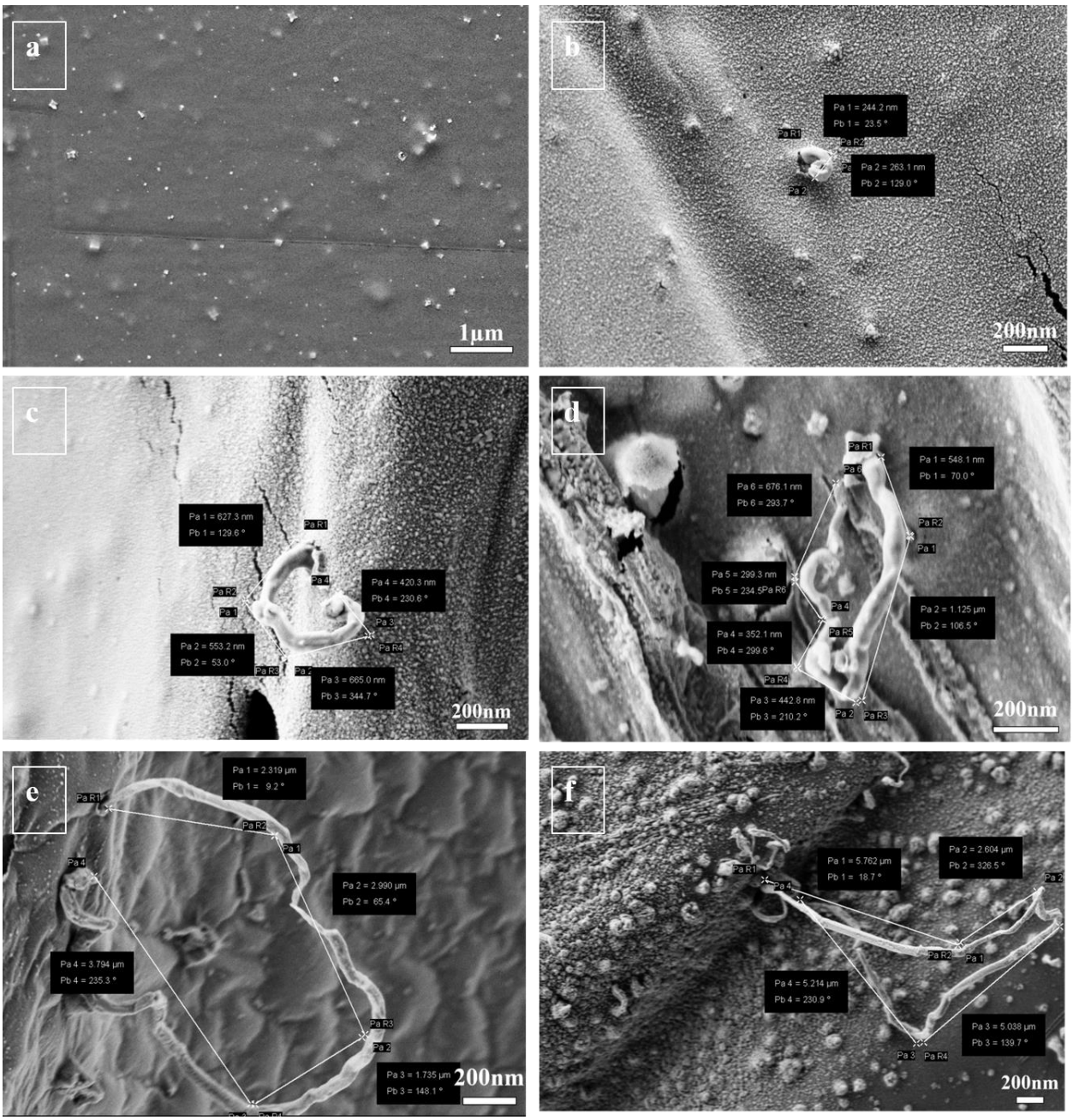

Figure S14 SEM images representing the change in Ag NW length with respect to time. a (week 0), b (week 1), c (week 2), d (week 3), e (week 4) and f (week 7) represent growth of Ag NW with respective to change in time.