RSC Advances

Supplementary Information

From 1D to 3D: A New Route to Fabricate Tridimensional Structure *via* Photo Generation of Silver Networks

Huaizhong Shen,[a] Yuxin Wu,[a] Liping Fang,[a] Shunsheng Ye,[a] Zhaoyi Wang,[a] Wendong Liu,[a] Zhongkai Cheng,[a] Junhu Zhang,[a] Zhanhua Wang*[b] and Bai Yang*[a]

a State Key Laboratory of Supramolecular Structure and Materials, College of Chemistry, Jilin University, Changchun, 130012, P. R. China. E-mail: byangchem@jlu.edu.cn
b Laboratory of Organic Chemistry, Wageningen University and Research Center, Dreijenplein 8, 6703 HB, Wageningen, The Netherlands. E-mail: wzh12020915@gmail.com

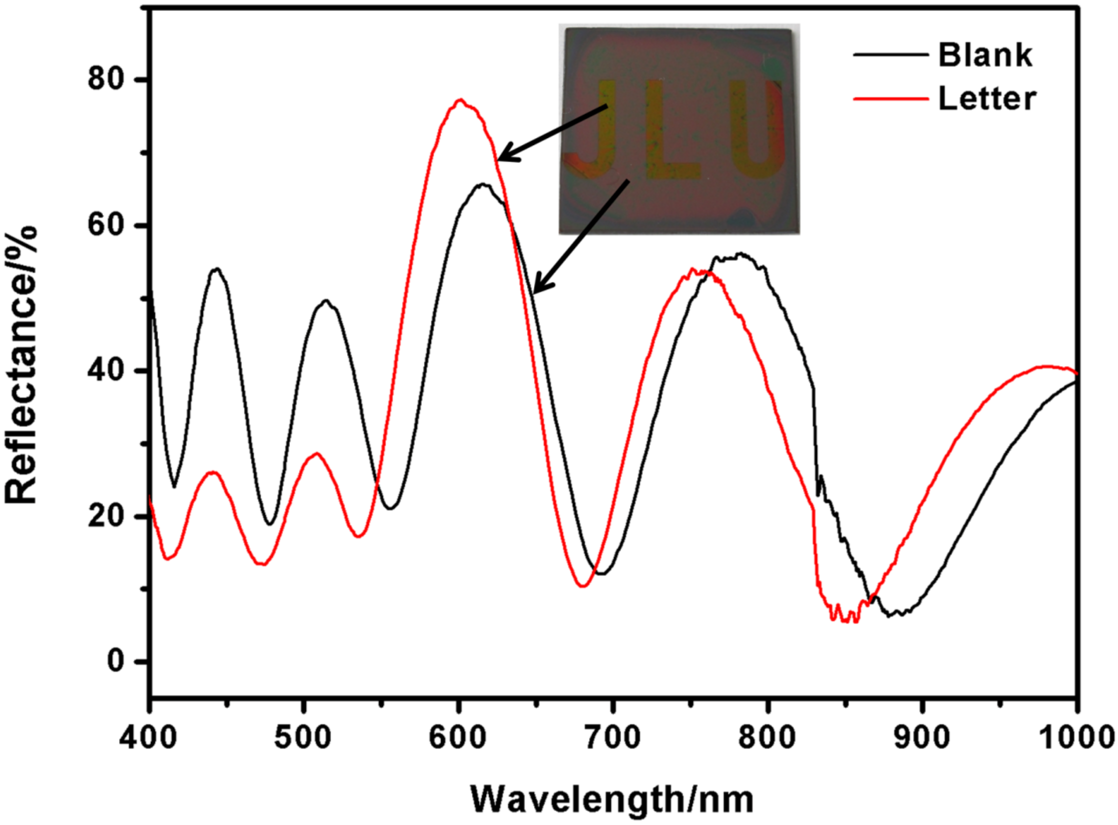


Fig. S1.Macro pattern of JLU on a 2×2 cm square silicon substrate (inset picture) and the corresponding reflectance spectrum.

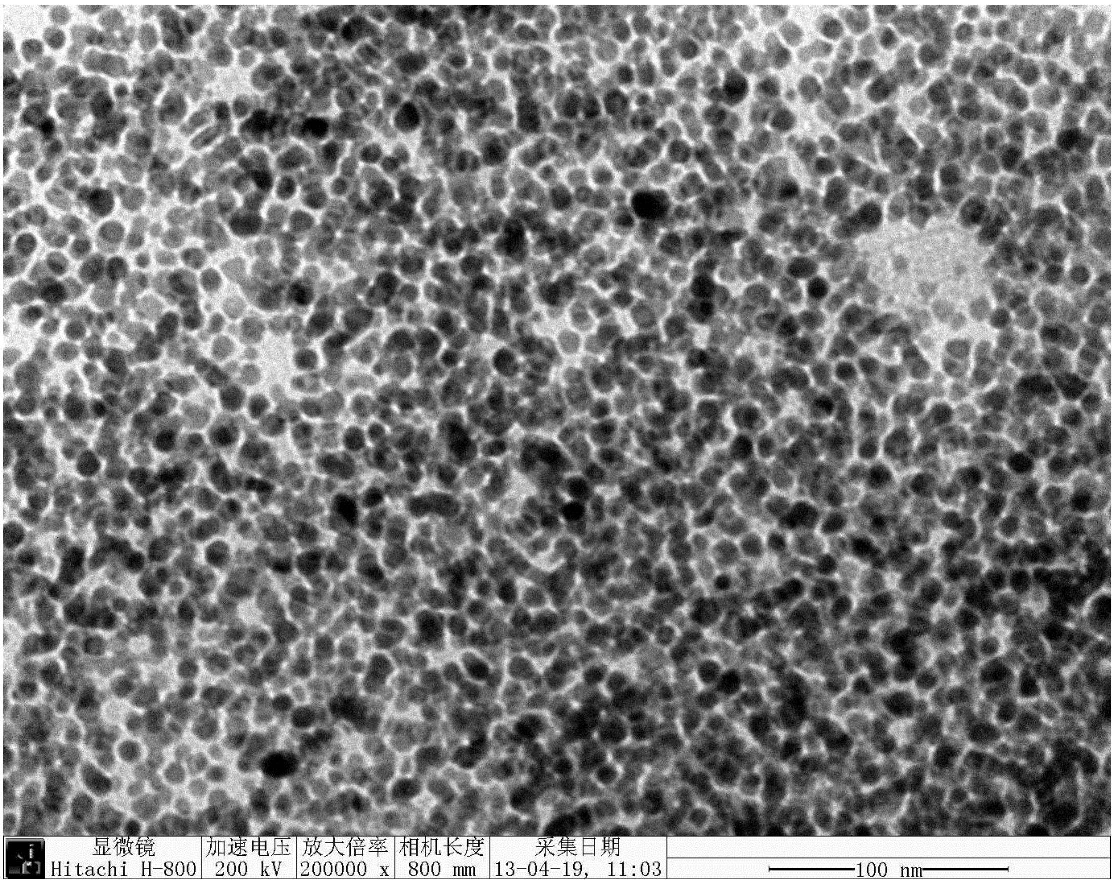


Fig. S2.Original TEM image of silver NPs embedded in PVA single film.

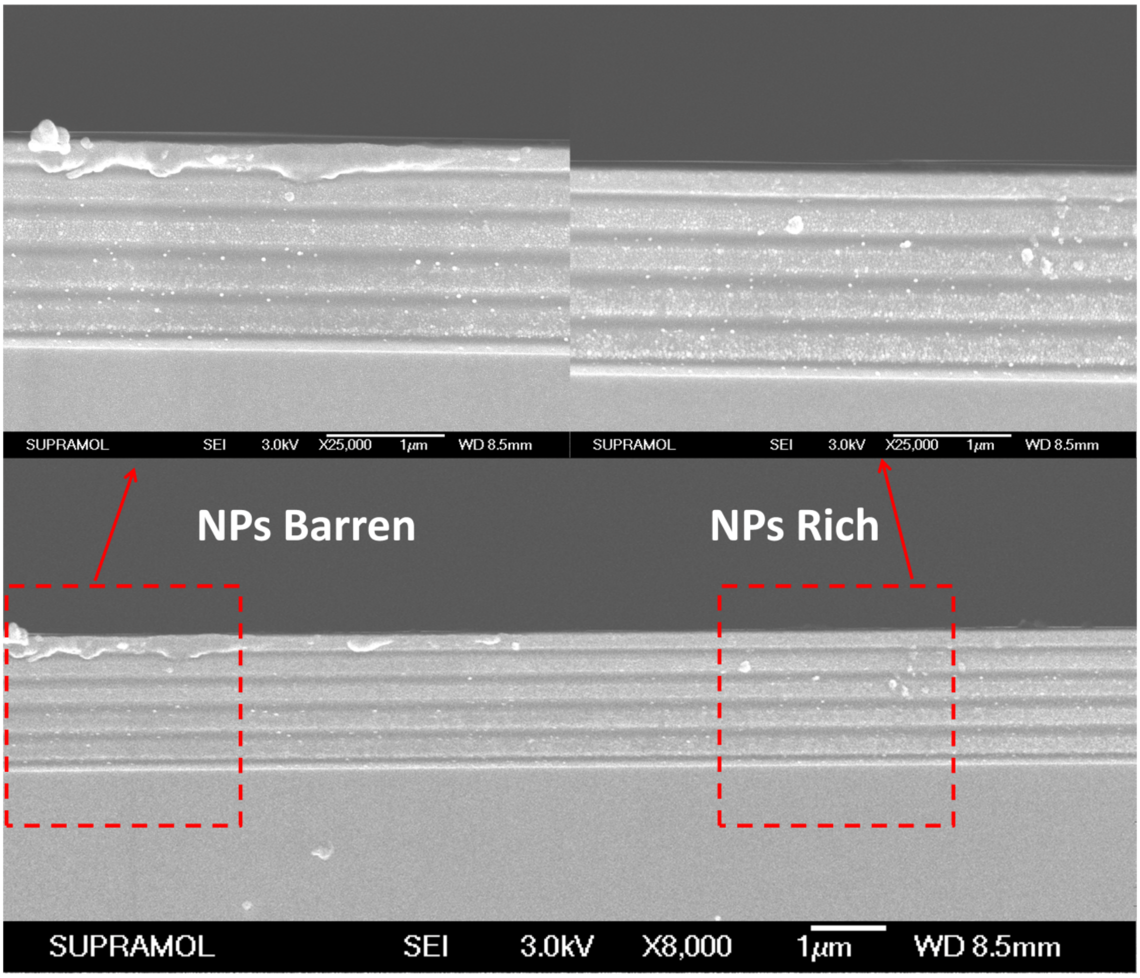


Fig. S3.Cross sectional SEM image of JLU sample taken in the position of the border between letter J and the blank space. The two SEM images on the top are magnified pictures of the two adjacent parts.

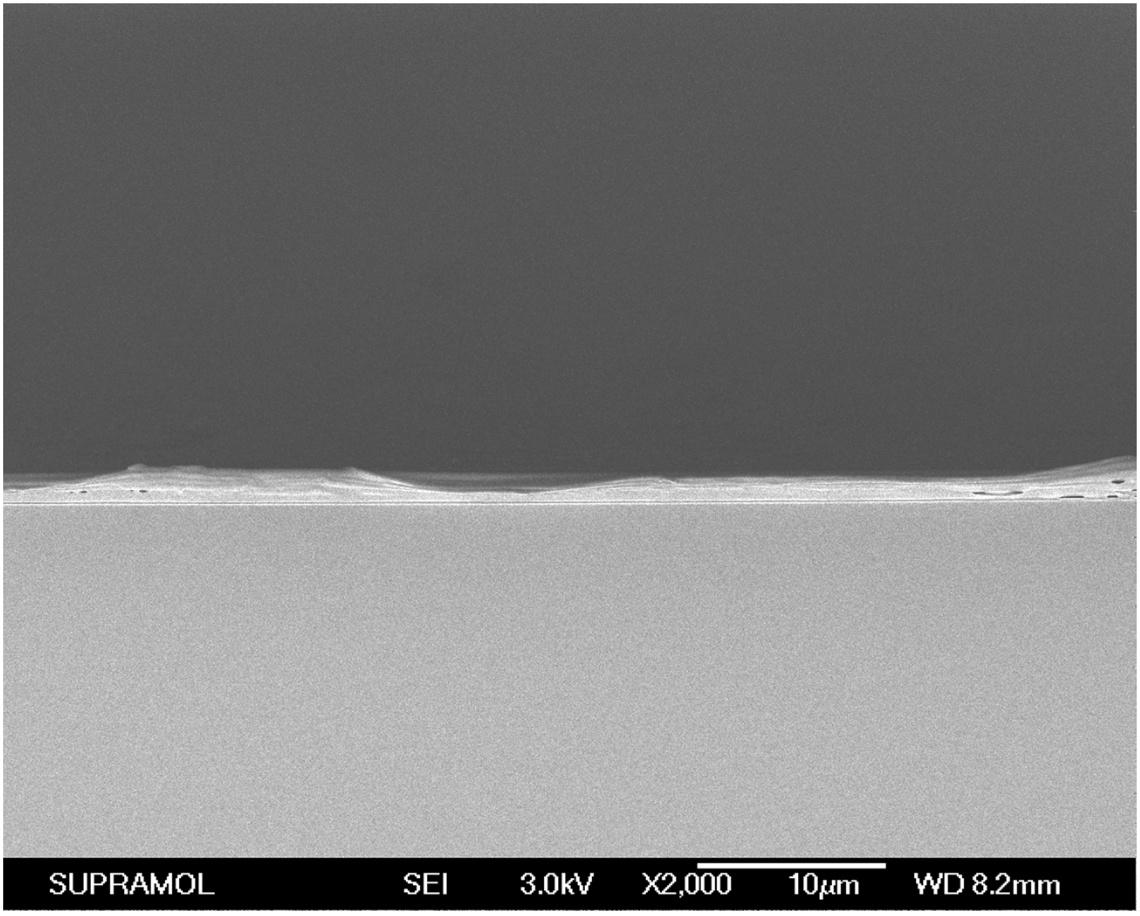


Fig. S4.Cross sectional SEM image of a sample exposed to UV light under 10 μm alternatively distributed stripe mask.

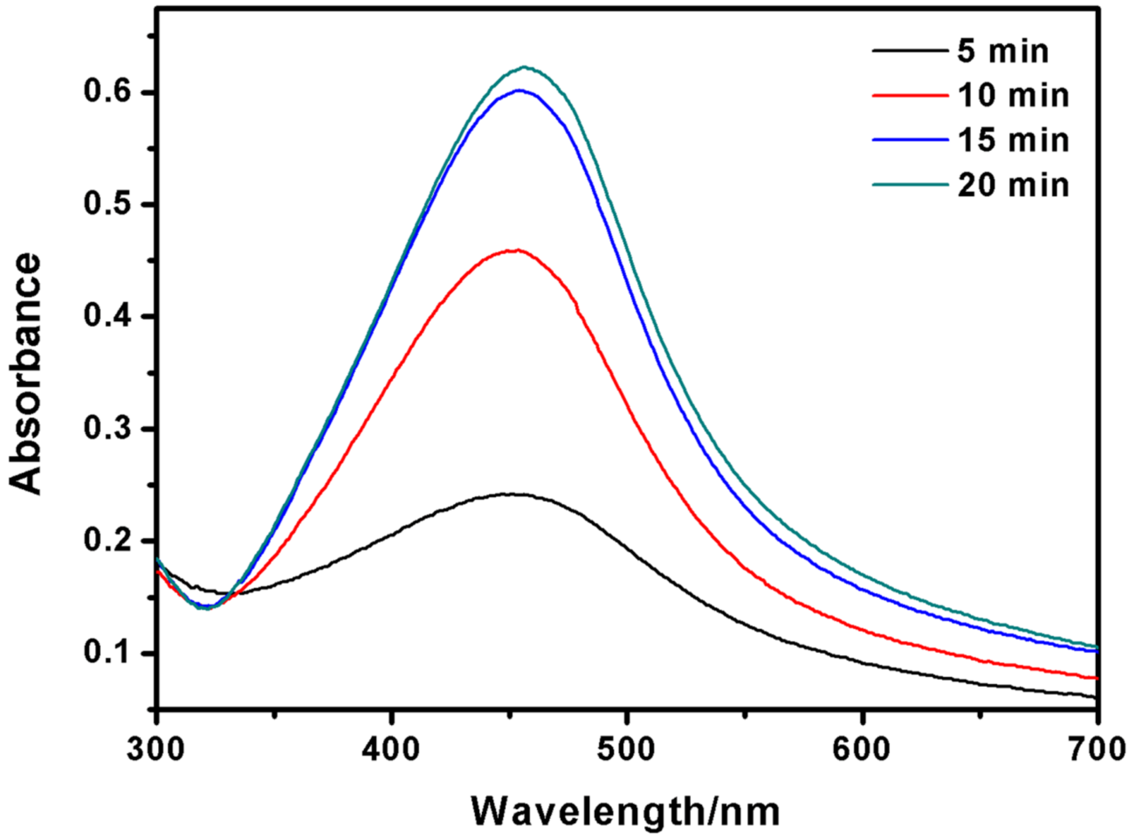
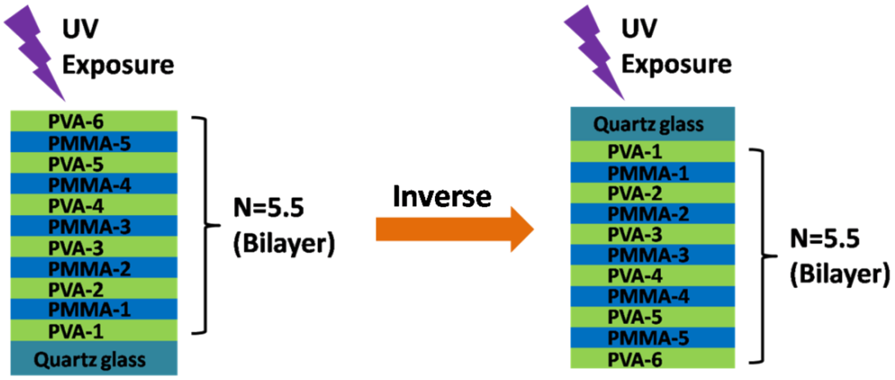


Fig. S5.Absorbance spectrum of Ag NPs composite single PVA film under different UV exposure duration.



Scheme S1.Schematic illustration of the sample making. First step: UV exposure from the PVA-6 side for different time duration of 0 min, 20 min, 40 min, 60 min and 80 min. Second: inversing the as prepared 5 samples and then exposing them to the same UV source from quartz side for different time.

Five samples on quartz glass substrate which are exposed to UV irradiation for 0 min, 20 min, 40 min, 60 min and 80 min from the PVA-6 side at first (Scheme S1). Quartz glass is chosen for they have no absorption and relatively high transmission in the wavelength range of 200 to 1400 nm, it has no influence on the UV exposure and subsequently reflection measure steps. After that, the five samples are all inversed and exposed to UV irradiation from quartz glass side for different time duration and then are taken reflection measurement from the quartz glass side. The results are shown in Figure S6.

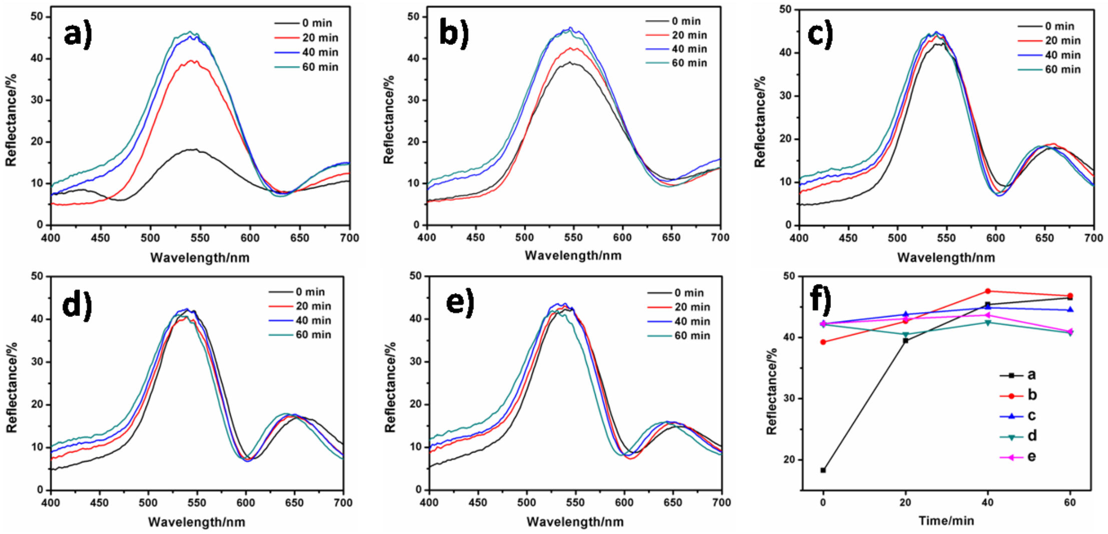


Fig. S6.a-e) Reflectance spectra of sample a-e under different time duration, f) summary of the reflection intensity change as a function of exposure time.

Figure S6a-e are the reflectance spectra under different UV exposure time taken from the quartz glass side. Before the UV exposion from quartz side, the samples shown in figure S6a-e are exposed to UV irradiation for 0 min, 20 min, 40 min, 60 min and 80 min respectively. For sample a which has no UV irradiation before UV exposue from the quartz side, the reflectance intensity increase dramatically from 18.26% to 46.51% after exposed to UV from quartz side while for sample b the increase of reflection intensity is from 39.25% to 46.81%. However, for the samples which are exposed to UV irradiation for 40 min or more from the PVA-6 side, the reflectance intensity do not change much after the irradiation from quartz side. Figure S6f summarize the reflection change of such 5 samples. The obvious reflection change for sample a and b is caused by the newly formed Ag NPs during UV exposue from the quartz side, more zero-valent silver will increase the film's RI value, thus bringing change to the reflection spectra just like the situation in Figure 5a. In other words, it means that after 20 min UV exposure from PVA-6 side, there is still silver ions embedded in the polymer film especially in the bottom PVA layers, such as PVA-1 layer. So when the sample is put inversed to the UV source with quartz glass side on top, the silver ions continue to be reduced to form silver NPs. While for the samples with no obvious reflection intensity change, it indicates that most of the silver ions are reduced during the UV exposure from PVA-6 side, even the silver ions belonging to the bottom PVA layers. So when exposed from the quartz side, there is not much more generation of Ag NPs thus the reflection intensity remain almost the same. This reflection measurement from the quartz side verifies that the formation of Ag NPs during UV exposure is a kinetics control process, which means that we can convert most of the silver ions into zero-valent silver NPs through extending the exposure time. So in the case of our experiments, the doping amount of silver nitrate in all the PVA layers in one sample is the same and most of the ions can be reduced to zero-valent silver after a certain period of exposure time. The percentage of Ag as reduced metal in top and bottom layer will have no obvious difference.

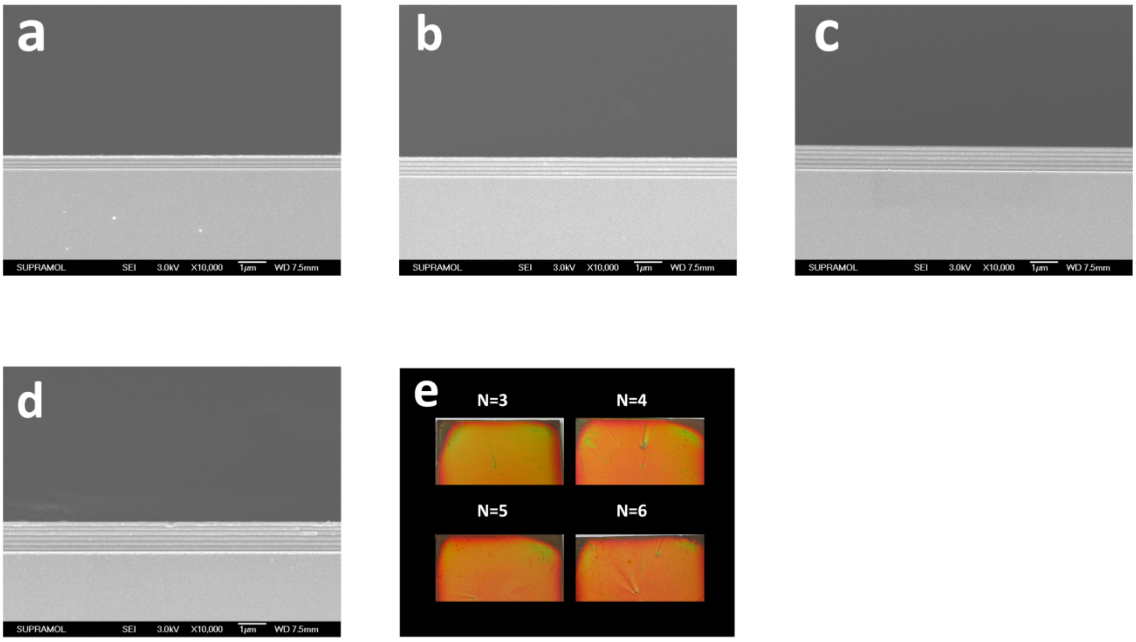


Fig. S7.a-d) Cross sectional SEM images of samples with different bilayers from 3 to 6, e) photographs of corresponding samples.

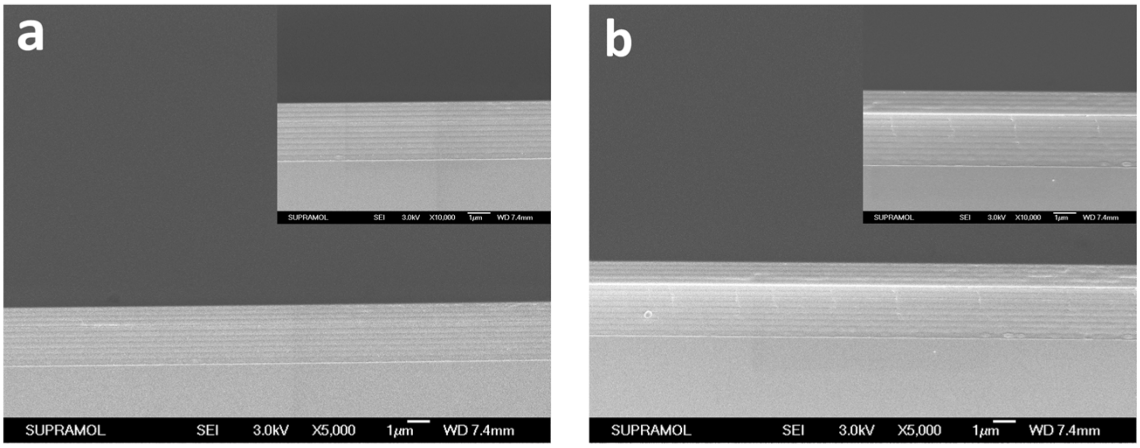


Fig. S8.Cross sectional measurement of the samples consisting of a) 11 and b) 14 bilayers.

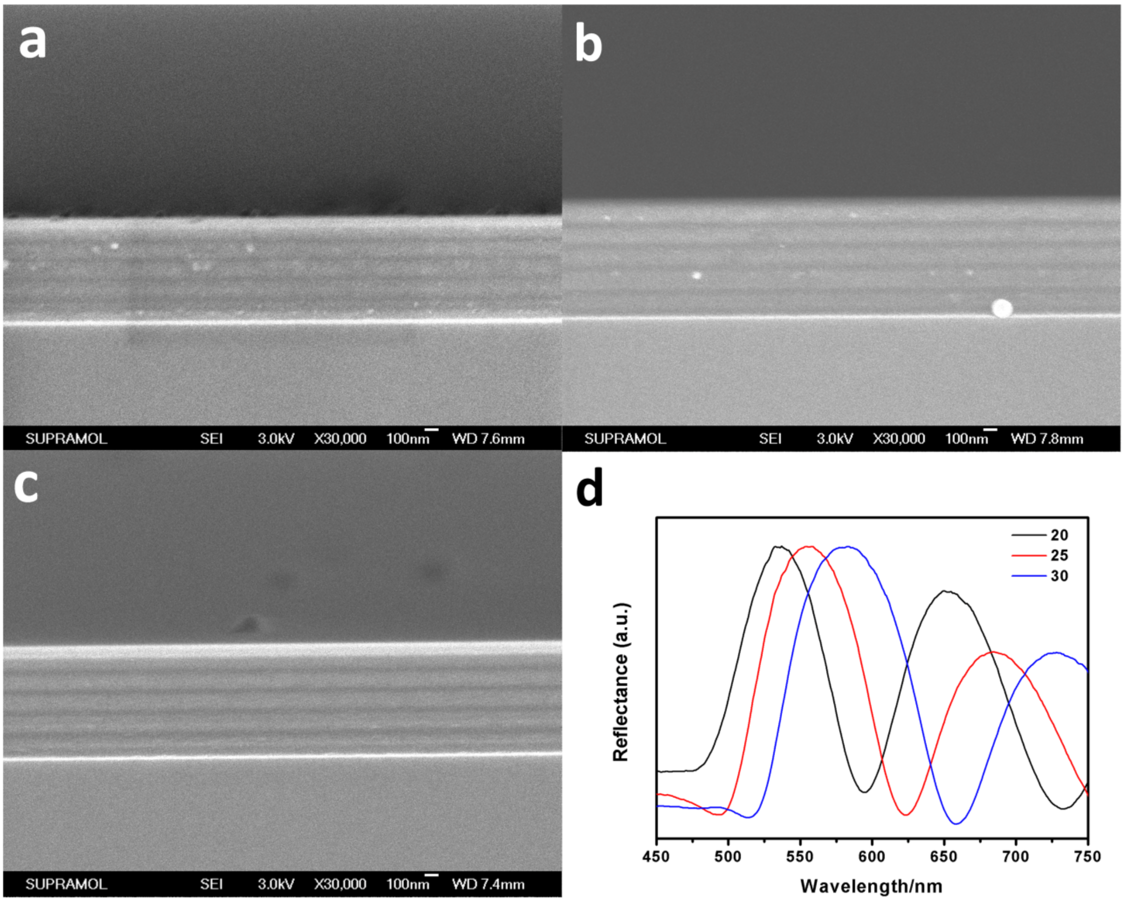


Fig. S9.a-c) Cross sectional SEM images of samples with PMMA solution concentration varies from 20, 25 to 30 mg/ml. d) Corresponding reflectance spectra of the three samples.

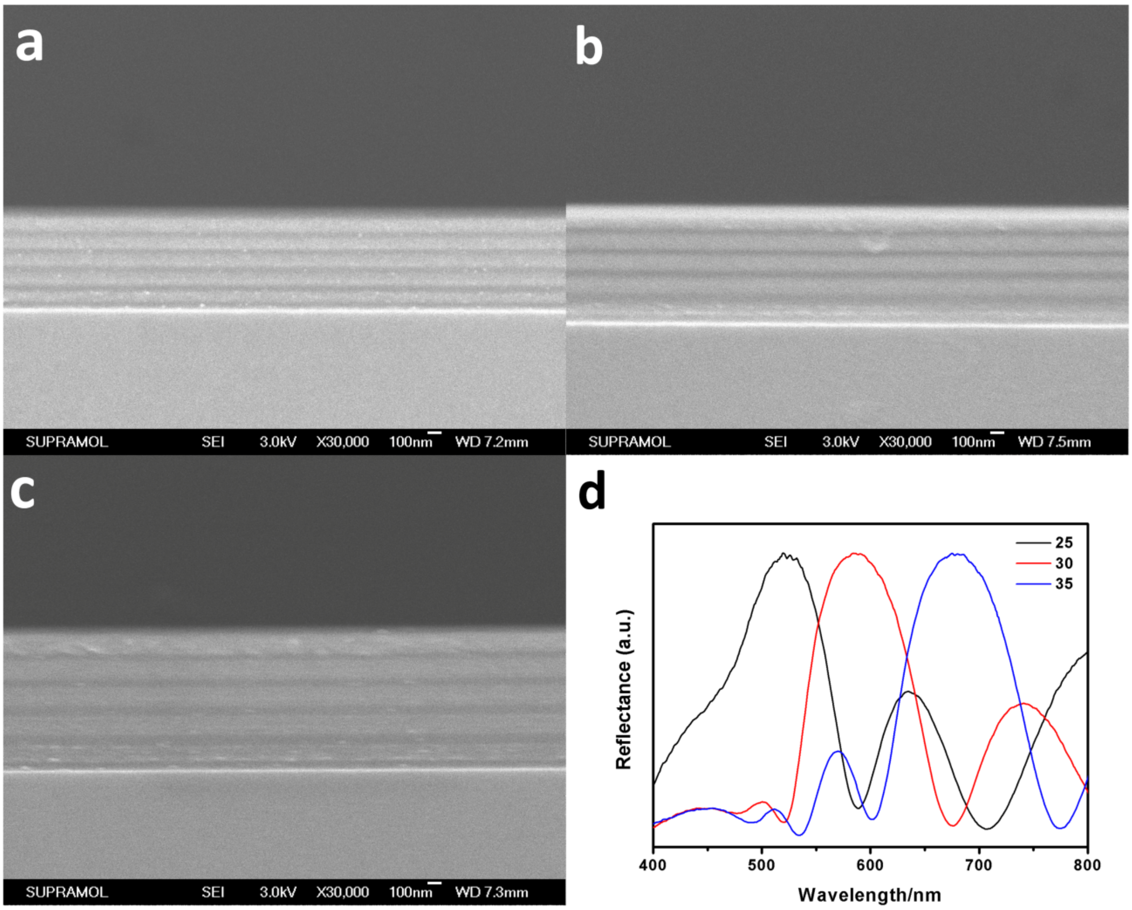


Fig. S10.a-c) Cross sectional SEM images of samples with PVA solution concentration varies from 25, 30 to 35 mg/ml. d) Corresponding reflectance spectra of the three samples.