

Article

Hybrid perovskite/polymer materials: Preparation and Physico-chemical Properties

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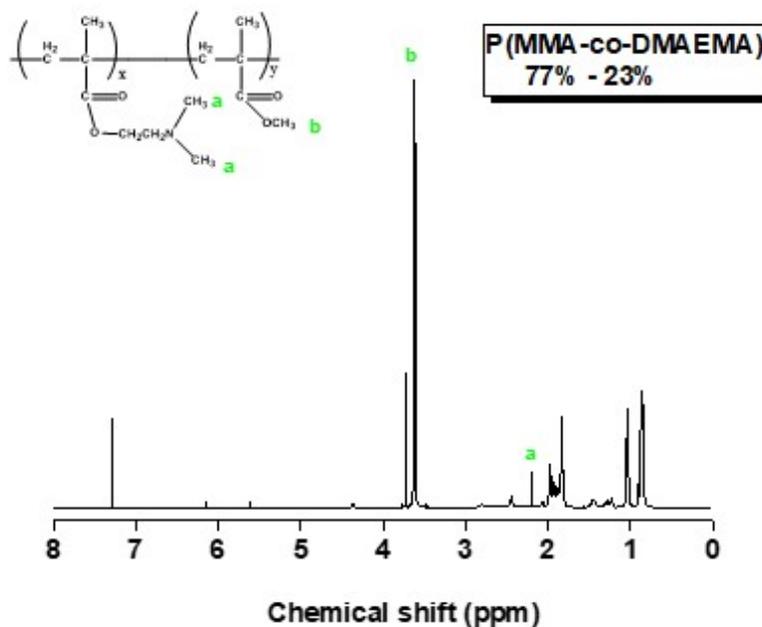


Figure S1. $^1\text{H-NMR}$ spectrum of the P(DMAEMA-co-MMA) random copolymer. The deuterated solvent that was used in order to obtain the spectrum is CDCl_3 .

The $^1\text{H-NMR}$ spectroscopy confirmed the expected chemical structure and composition of the synthesized random copolymer. The composition was calculated using the MestRenNova analysis program.

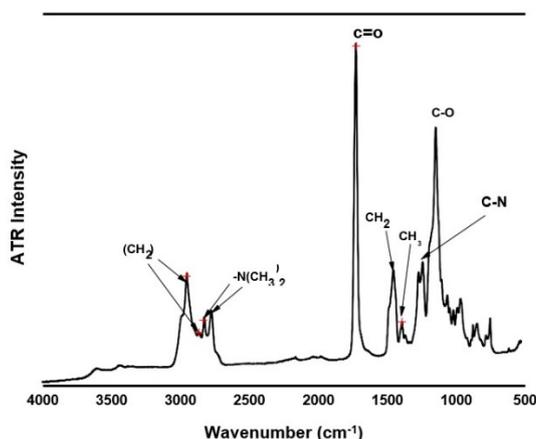


Figure S2. ATR-FTIR spectrum of the P(MMA-co-DMAEMA) random copolymer.

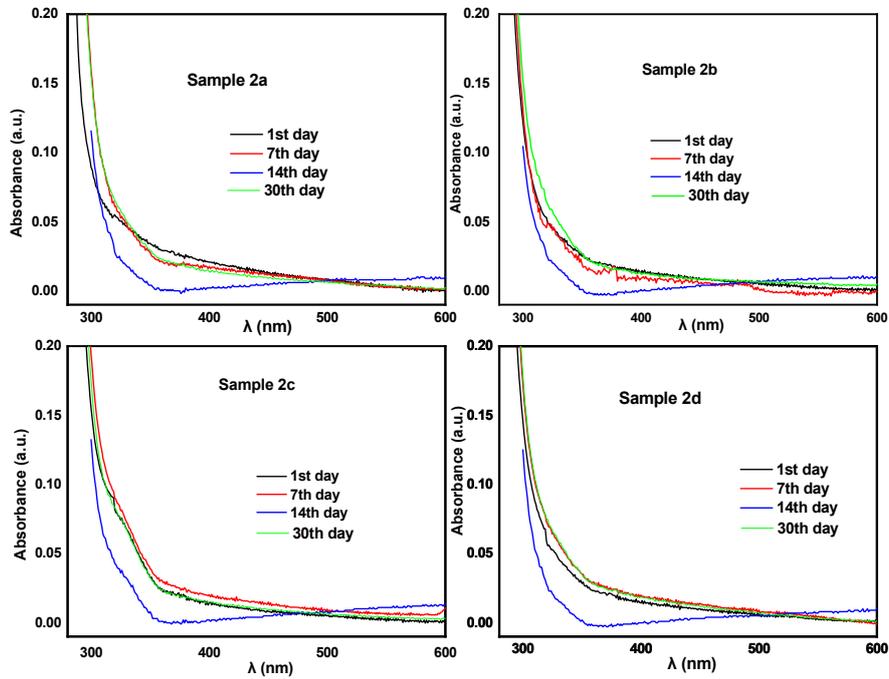


Figure S3. UV-Vis absorption spectra of solutions 2a, 2b, 2c and 2d from 1st (black line), 7th (red line) 14th (Blue line) and 30th (green line) day

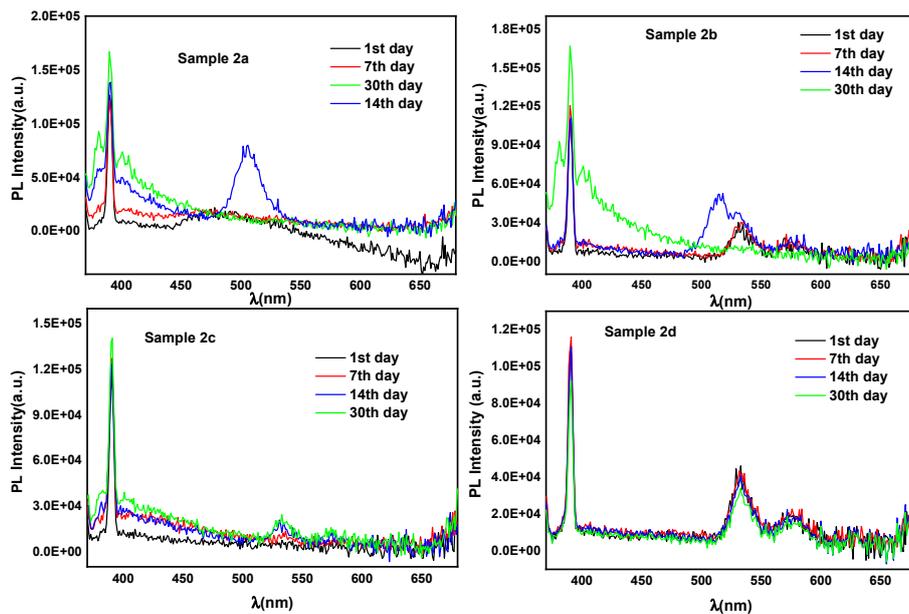


Figure S4. Fluorescence emission spectra of solutions 2a, 2b, 2c and 2d from 1st (black line), 7th (red line) 14th (Blue line) and 30th (green line) day

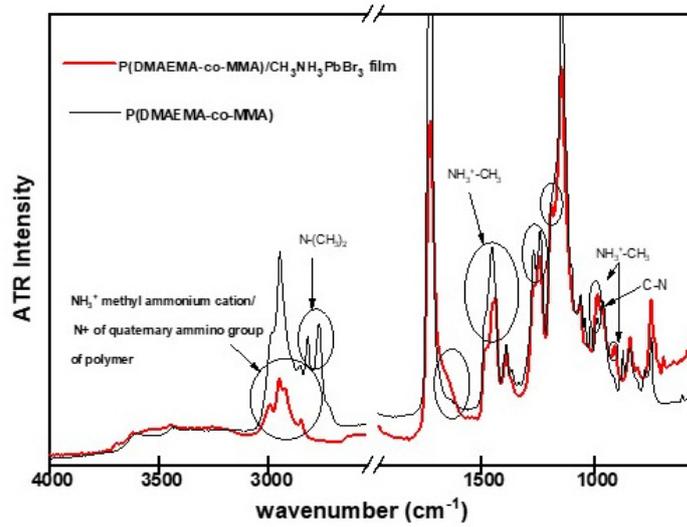


Figure S5. Comparative ATR-FTIR spectra of the hybrid material (red line) and polymer matrix (black line)

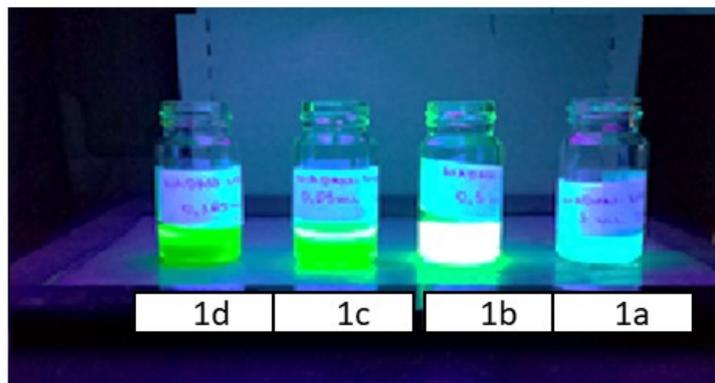


Figure S6. Photo of solutions 1a, 1b, 1c and 1d under UV light, on the day they were prepared.

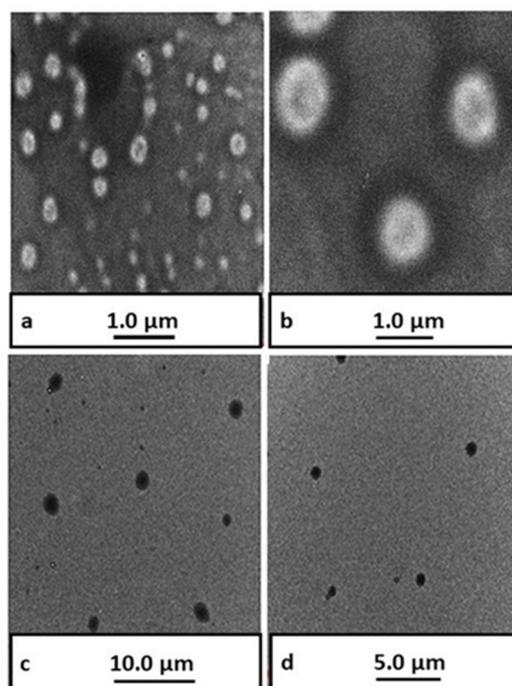


Figure S7. TEM images from sample 1b a) and b), sample 1c c) and d)

Note: The obtained morphologies of the hybrid perovskite/random polymer nanostructures resulted by following the specific TEM sample preparation protocol that is described in Section 2.3. Characterization (main text). Following a different sample preparation protocol involving centrifuging the nanocrystals out of the growth solution and redispersing them before drop-casting on a TEM grid may lead to different morphologies, possibly unaffected by particle growth after solvent evaporation.

In order to investigate the formation and the morphology of the perovskite-copolymer hybrid nanostructures, TEM studies were performed. From the TEM images shown in Figure S7 we can presume that the nanostructures formed by the random copolymer and perovskite nanocrystals have spherical morphology.

Moreover, no difference in morphology of the nanoparticles is observed, by altering the concentration of the perovskite solution. In all cases, the hypothesis of the encapsulation of the perovskite nanocrystals into the DMAEMA segments seems to be confirmed. This phenomenon can be explained due to the formation of intermolecular bonds between the nitrogen atom of the DMAEMA segment and the lead atom of the perovskite nanocrystal. Comparing DLS and TEM size results, a significant difference is observed. DLS measurements have shown nanoparticles of smaller diameter, however size calculations from TEM images show particles of larger diameter. More specifically, DLS experiments are carried out in the solution state where the hybrid nanoparticles are dispersed and exhibit colloidal stability so that they maintain their small size, due to MMA characteristic ability to avert precipitation and increase insertion of solvent within the nanoparticle. The last feature would result in size increase (swelling) of the examined hybrid nanoparticles. On the contrary, TEM measurements are carried out in the dry state. Samples for TEM were prepared by casting a droplet of a solution of the examined hybrid nanostructures on copper grids coated by Formvar carbon film. Afterwards, the organic solvent was evaporated. Measurements were conducted after solvent evaporation. Consequently, we presume that solvent evaporation causes nanoparticle spreading on the substrate or even nanoparticle aggregation, resulting in structures of larger size.