Electronic Supplementary Information for:

All-polymer methylammonium lead iodide perovskite microcavity

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$MAPbI_3$ characterization

Figure S1a reports the diffractogram of the $MAPbI_3$ thin film. The pattern is consistent with the formation of $MAPbI_3$ (tetragonal crystal system; space group I*4/mcm*) with the presence of PbI_2 impurities (diffraction peaks at 12.6° and 38.3°).[1] The atomic force microscopy characterization of the surface morphology indicates that the deposition process favor film with roughness of 8 nm (FigureS1b).

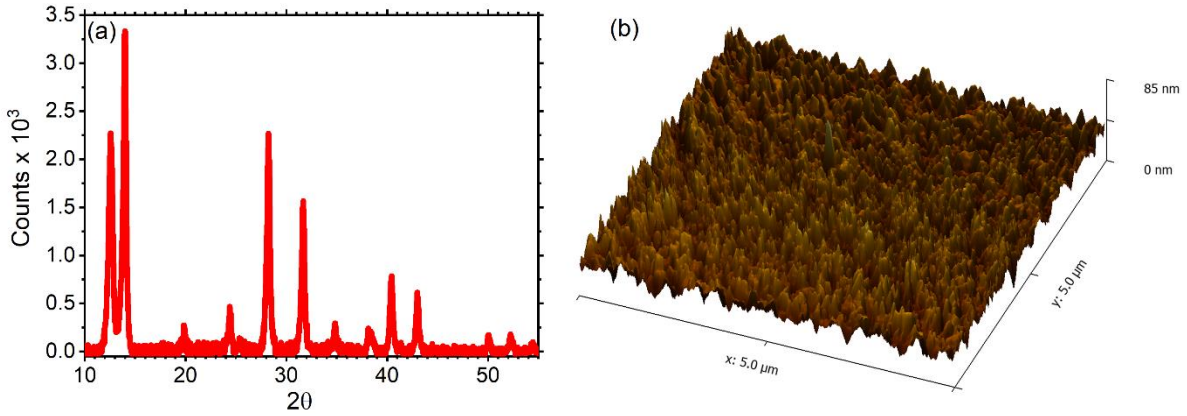

Figure S1 *(a) X-ray diffraction pattern and (b) atomic force microscopy micrograph of the $MAPBI_3$ thin film.*

Reflectance spectra of the microcavity:

The reflectance spectra of Figure S2a are described in the main text. Figure S2b compares the spectrum of the microcavity with two simulation obtained via transfer matrix method as described in the Experimental section. The experimental spectrum (black line) was modelled fitting the layer thicknesses (green line in figure S2b). From the fitting we retrieved thicknesses of 125 nm for the PVK layers, 134 for the CA layers, 120 nm for the top Hyflon® AD polymer layer and 79 nm for the bottom one. The perovskite resulted 91 nm, while the PVK layer between Perovskite and Hyflon® AD polymer is 18 nm thick. Such fit provided a cavity mode cantered at about 780 nm with finesse Q=780. To explain the difference between the experimental and the fitted data, we inserted the roughness of the perovskite thin film reported in Figure S1 and those of PVK and CA previously estimated for similar systems in the model.[3] To achieve this goal we calculated the reflectivity of 1025 different ideal systems where each layer thickness is randomly chosen from a gaussian distribution centered around the previously described thickness values. We supposed that the gaussian distributions have a standard deviation of 0.3 nm for the PVK layers, 1 nm for the CA layers,[3] and 8 nm for the perovskite layer. The red line of Figure S2b shows that the high rugosity of the perovskite layer reduces the intensity and increases the spectral width of the cavity layer with respect to the previous case providing a finesse of about 150, that is fully comparable with the experimental value.

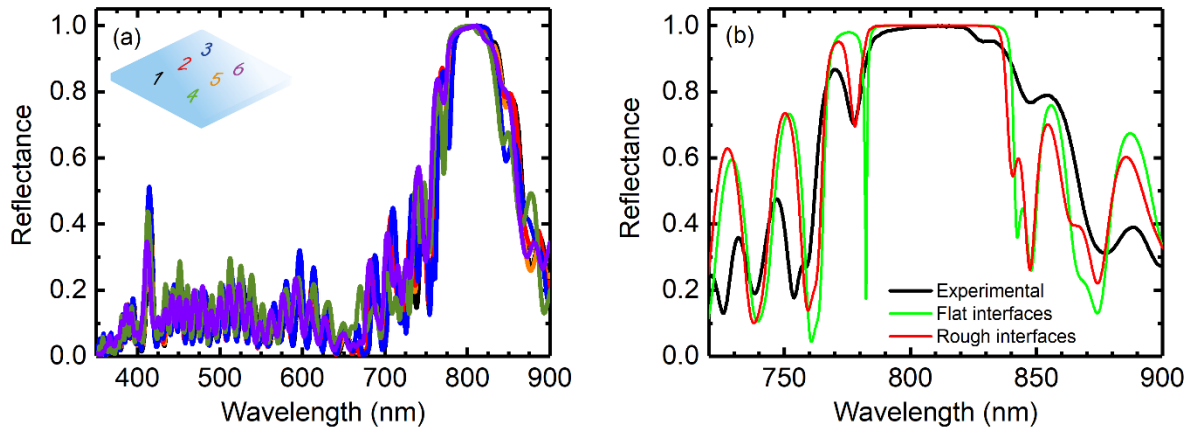

Figure S2 **(a)** *Reflectance spectra of the microcavity containing the $MAPbI_3$ film. The reflectance spectra were collected in different points of the microcavity (as indicated in the scheme in the inset) to demonstrate the homogeneity of the photonic structure. (b) comparison between experimental (vlack line) and modelled spectra of the microcavity considering flat interfaces /green line) and considering the interfacial roughness (red line).*

Optical properties of the reference microcavity:

As a reference to determine the spectral modification induced by the polymer DBRs, we have used the very same structure with a photonic band gap centered at a shorter wavelength. The blue-shift of the photonic band gap was obtained by reducing the thickness of the cellulose acetate layers in the polymer mirrors. The thickness reduction induced an expected blue-shift of the photonic band gap to 469 nm.

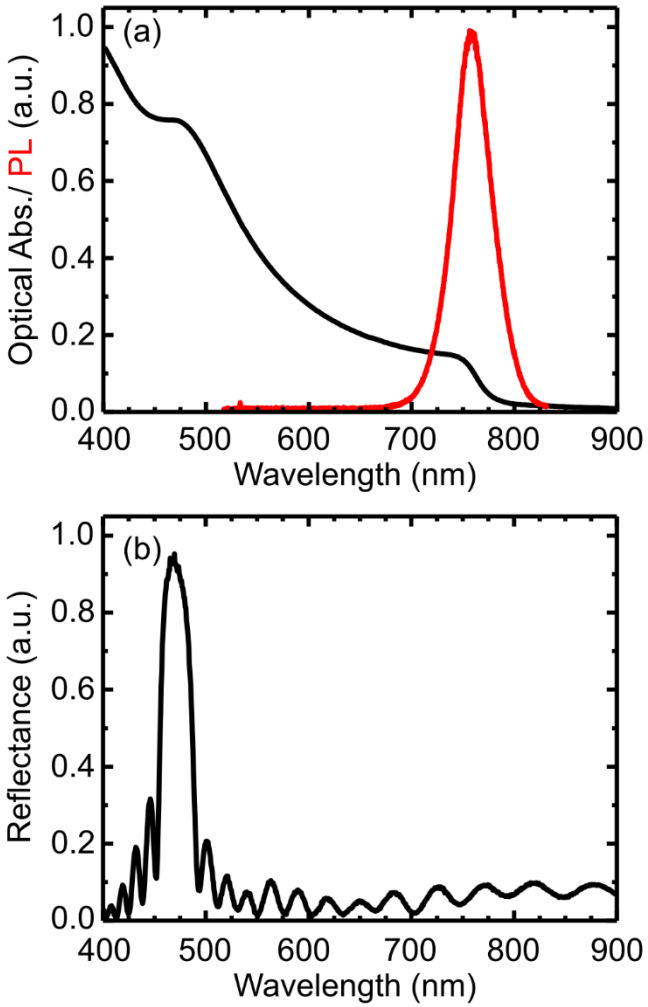

Figure S3 *(a) Photoluminescence and Optical absorption spectra of the $MAPbI_3$ film inside the reference (detuned) microcavity. (b) reflectance spectra of the reference microcavity showing a photonic band gap at 469 nm. Thanks to the blue-shift photonic band gap, the photoluminescence spectrum of the $MAPbI_3$ film is unperturbed.*

Photoluminescence Vs collection angle spectra:

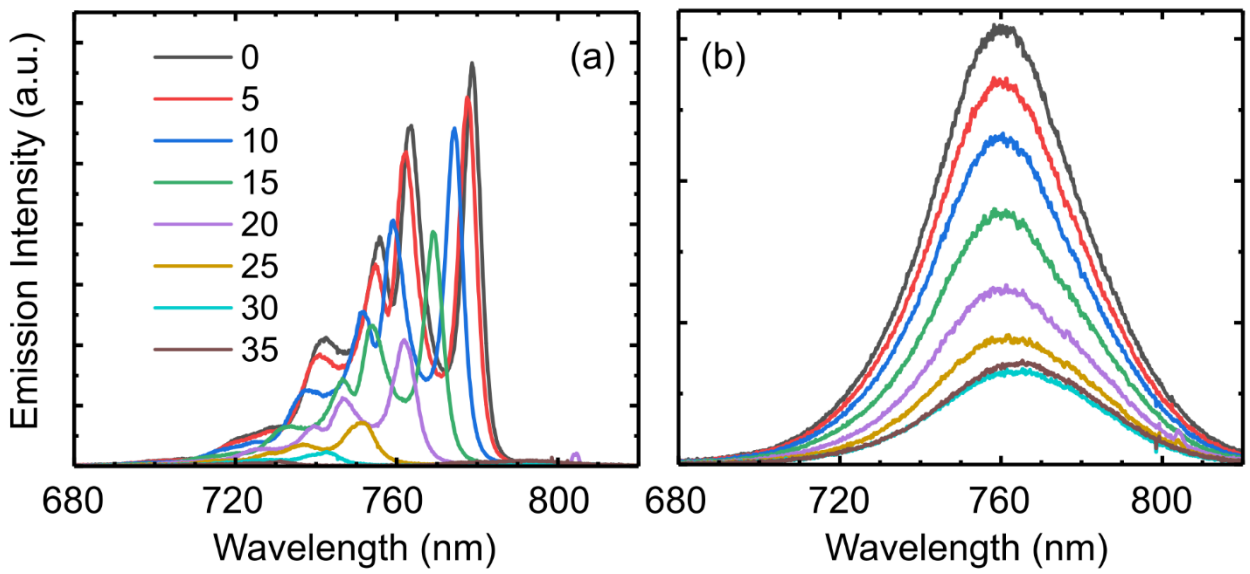

Figure S4 *Photoluminescence spectra of the $MAPbI_3$ film enclosed in the microcavity (a) and in the reference (b, i.e. de-tuned microcavity) vs collection angle. The photoluminescence spectra are strongly modified by the polymer mirrors which causes both spectral and angular redistribution.*

Transmittance VS collection angle spectra:

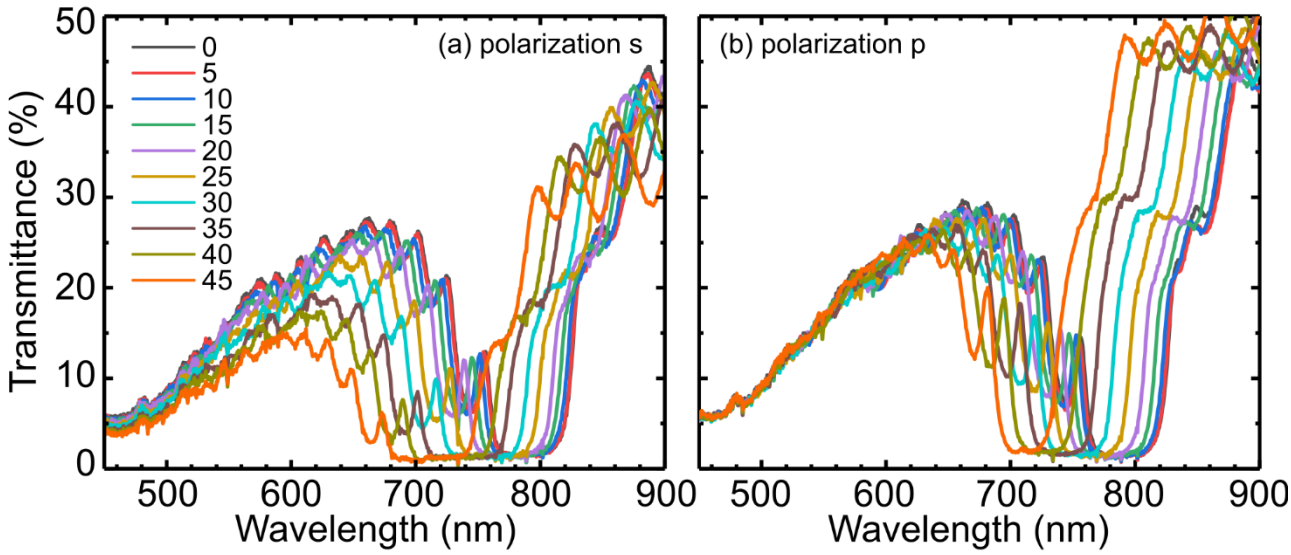

Figure S5 *Transmittance spectra of the microcavity Vs collection angle measured using polarized light: (a) polarization s, (b) polarization p. As expected, the photonic band gap shifts toward shorter wavelength upon increasing the collection angle*

References:

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2 J. Lagarias, J. Reeds, M. Wright and P. Wright, *SIAM J. Optim.*, 1998, **9**, 112–147.

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