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Supporting Information

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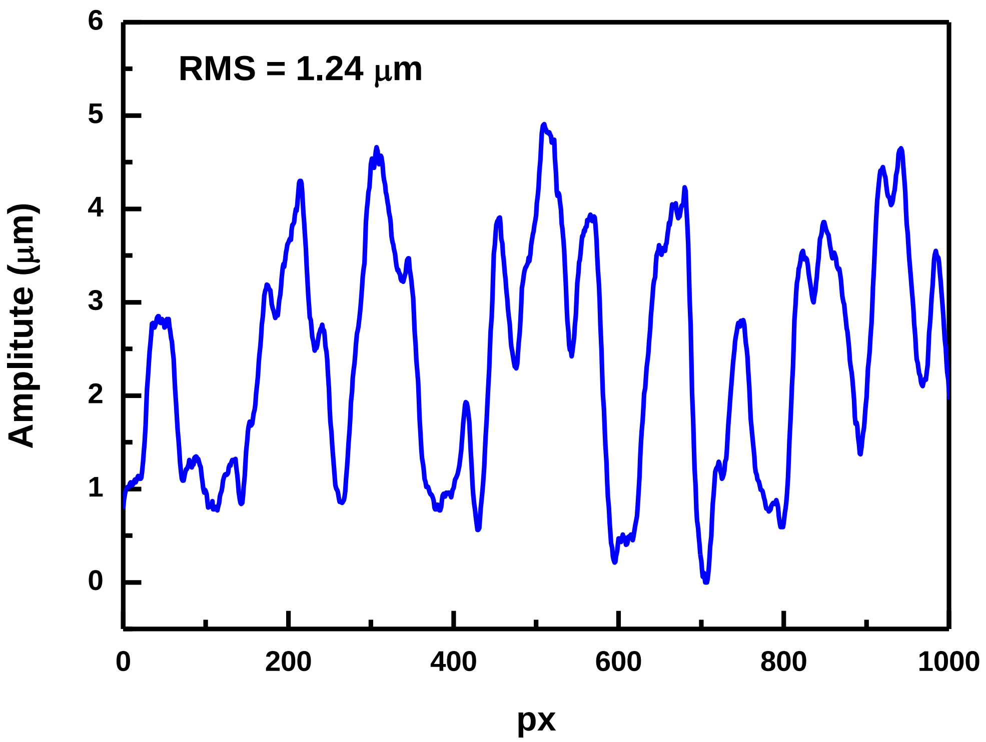

Figure S1. Line profile and roughness of picture reported in Figure 1b. The maximum thickness of perovskite clusters is 5 μm, with a roughness of 1.24 μm.

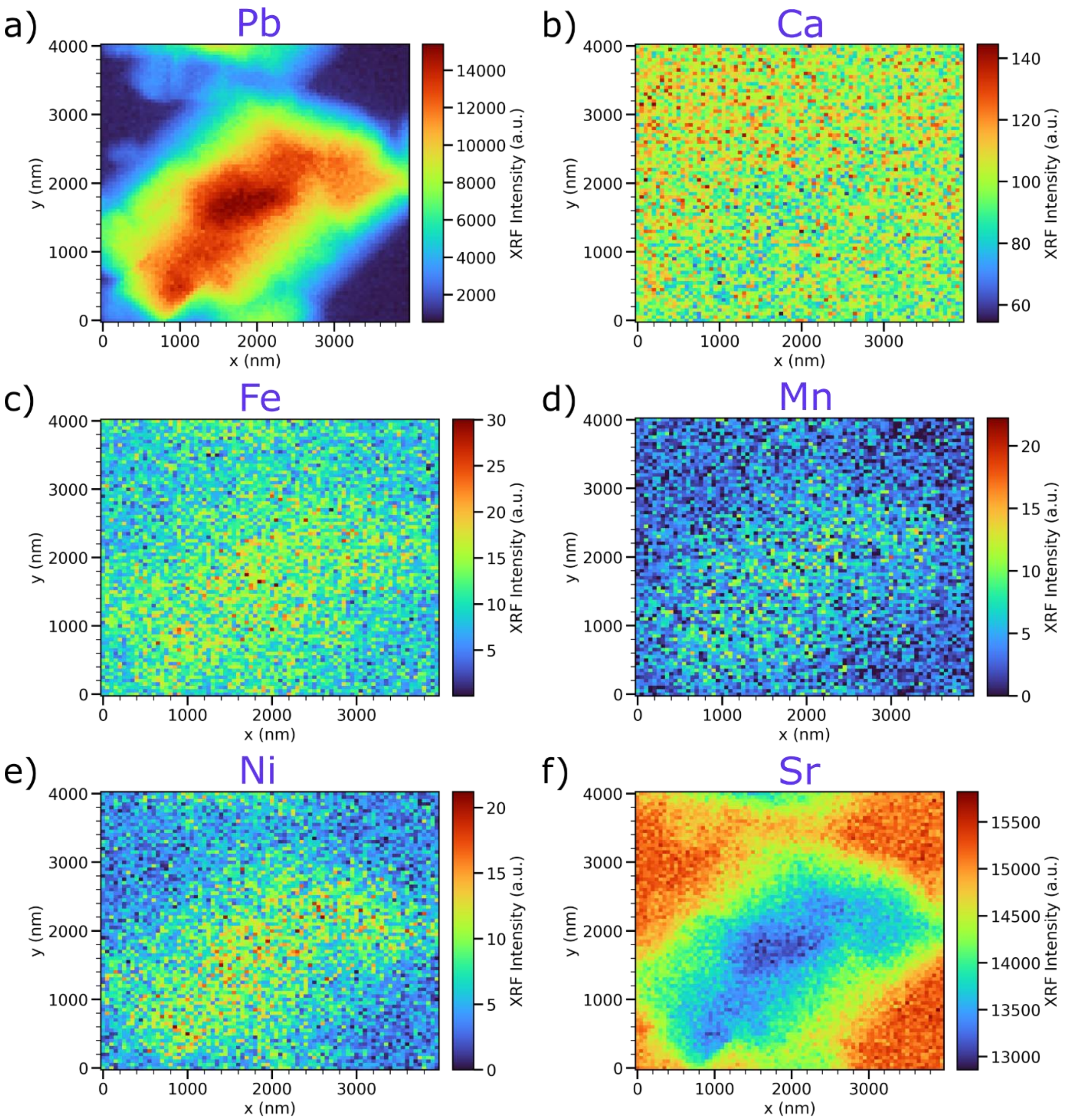

Figure S2. XRF maps of secondary elements. a) Pb distribution, as a reference. b) Ca, present as an impurity in the perovskite grains and in the glass substrate. c) Fe impurities. d) Mn impurities. e) Ni impurities. f) Sr. The map is negative image of the Pb distribution in the same area, demonstrating that the signal originates in the glass substrate.

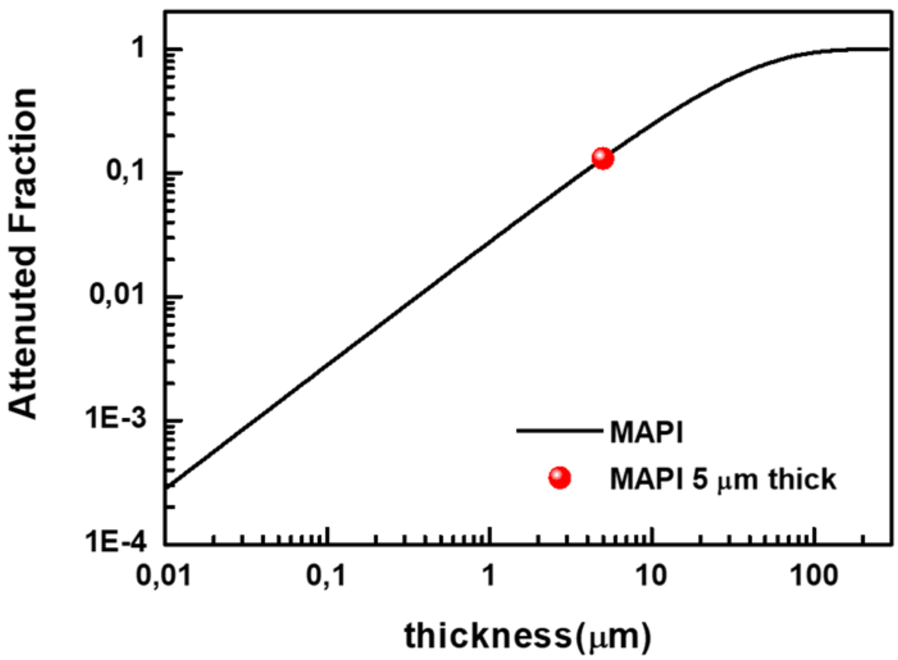

Figure S3. The calculated X-ray attenuated fraction of MAPI as function of film thickness for 17.5 keV monochromatic beam (the experimental condition used at ESRF-ID16B beamline). At 5 µm thick film the attenuated fraction is 13 % (red dot in the plot). X-ray absorption data taken from NIST database[24], and details on calculations reported in [9]. MAPI+PCBM samples have very similar values has PCBM is a polymer with low X-ray stopping power.

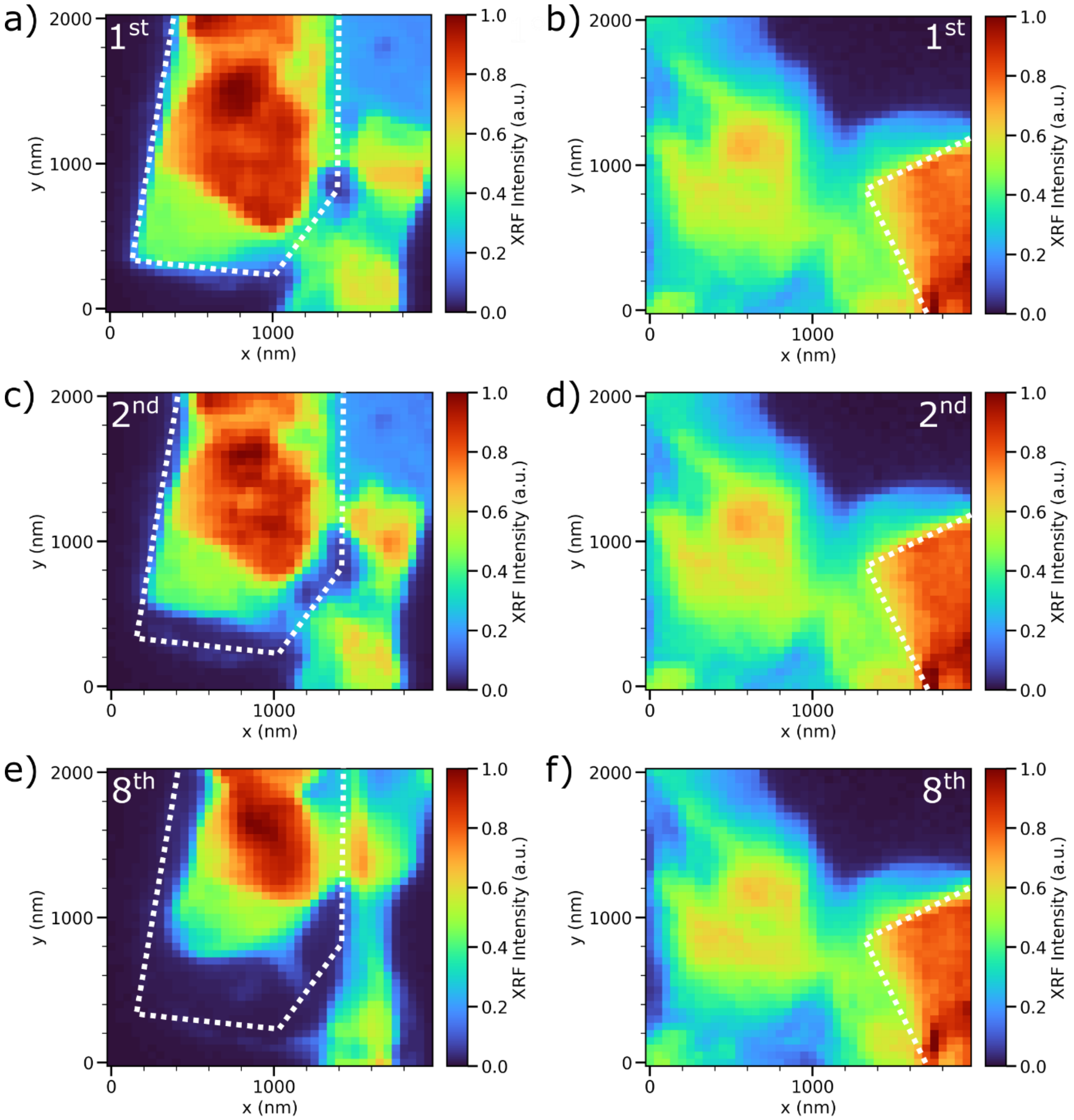

Figure S4. Sample degradation under X-ray beam. a, c, e) Consecutive Pb XRF maps acquired in high flux conditions (500 ms accumulation time and 10^{12} ph/s) showing a significant X-ray beam induced degradation. The white line is used as a reference for Pb distribution of one grain. b, d, e) Consecutive XRF maps of Pb distribution measured in low flux conditions (200 ms accumulation time and 10^{10} ph/s) showing no degradation after one scan and very limited modification after 8 scans.

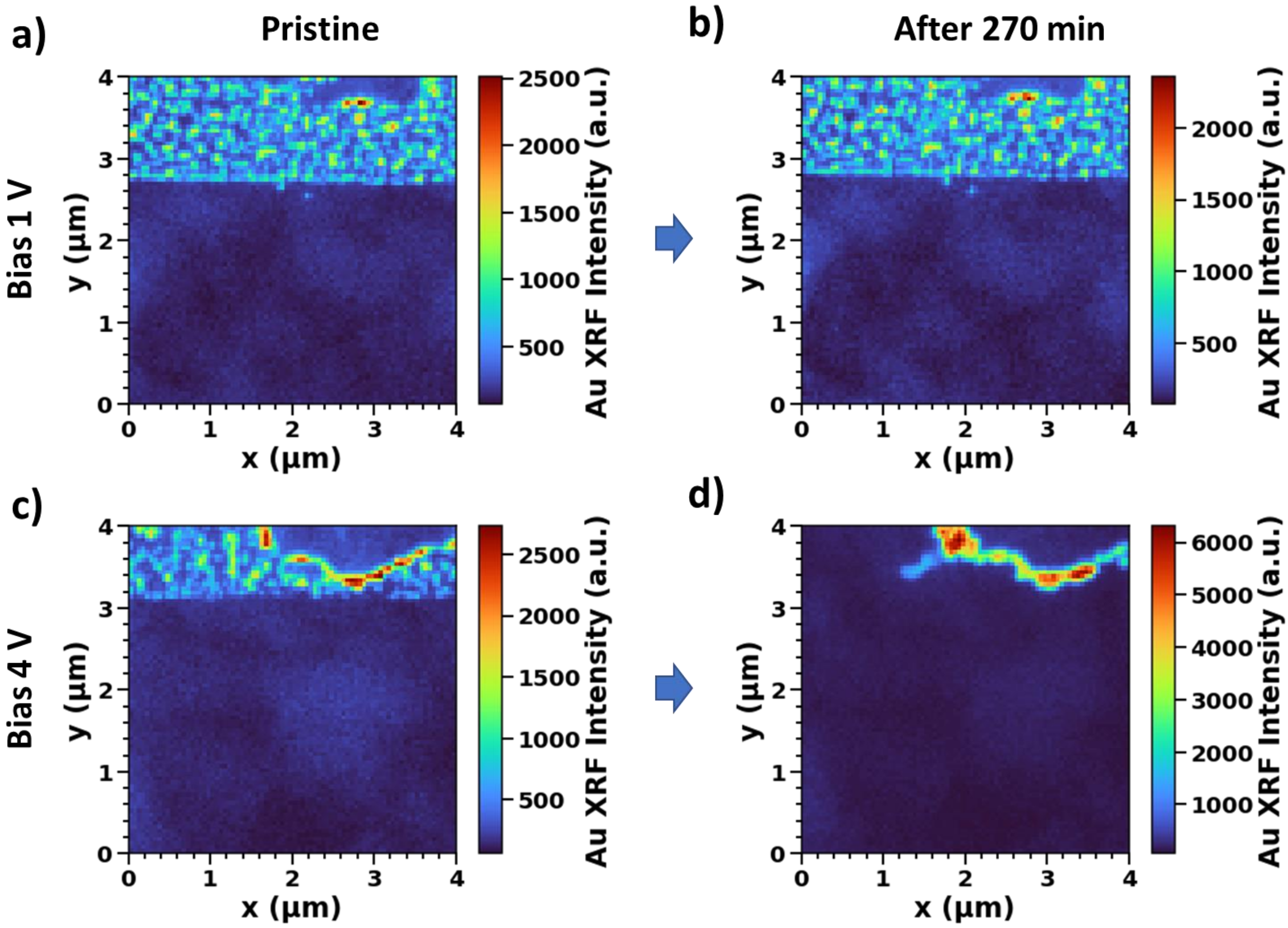

Figure S5. Electrodes stability. Au fluorescence of the metal electrode area for applied bias of 1V (a,b) and 4V (c,d). In pristine condition, i.e. immediately after the bias on (a) and (c); and after 270 minutes (b) and (d). No degradation is visible for 1V.

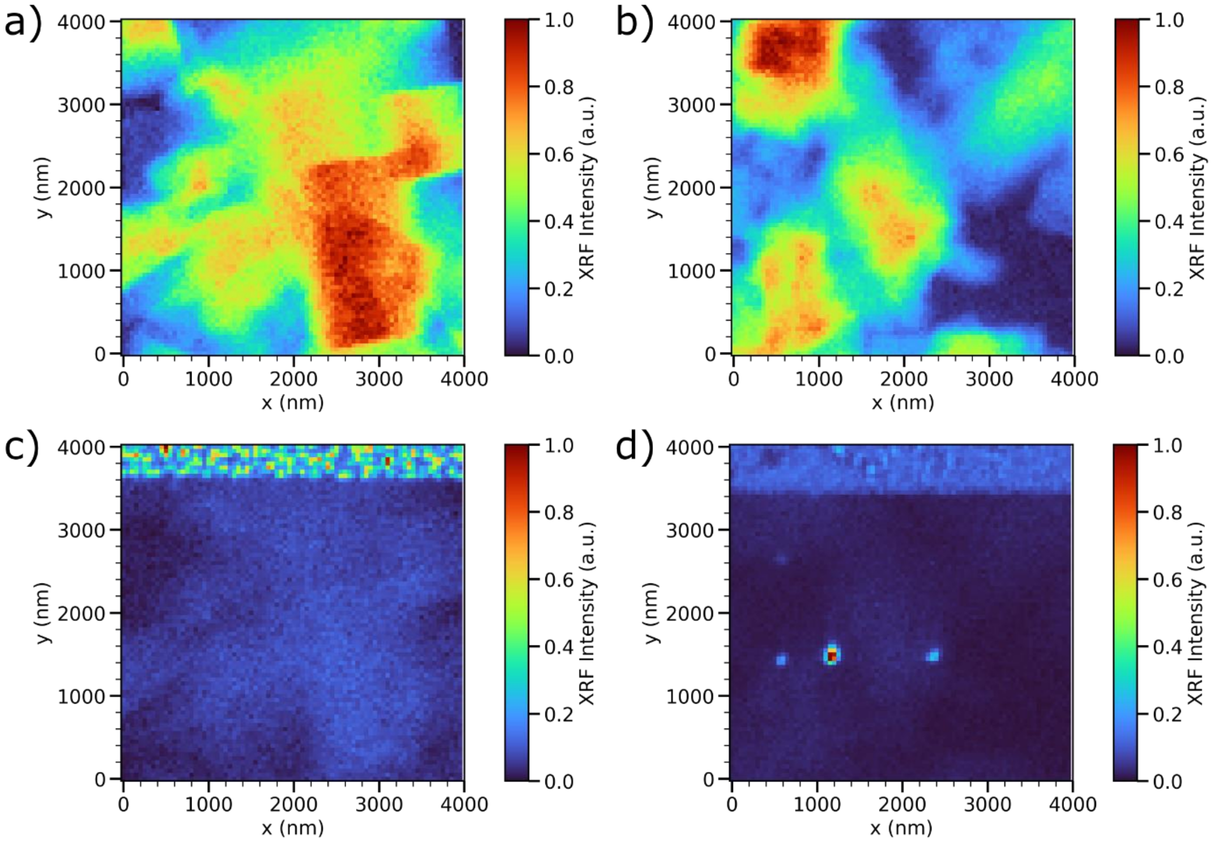

Figure S6. Au and I distributions. a, b) Iodine distribution for MAPI and MAPI+PCBM in the same areas reported in the main text. c, d) Gold distribution in the same area, near the edge of a finger in the interdigitated metal contact.

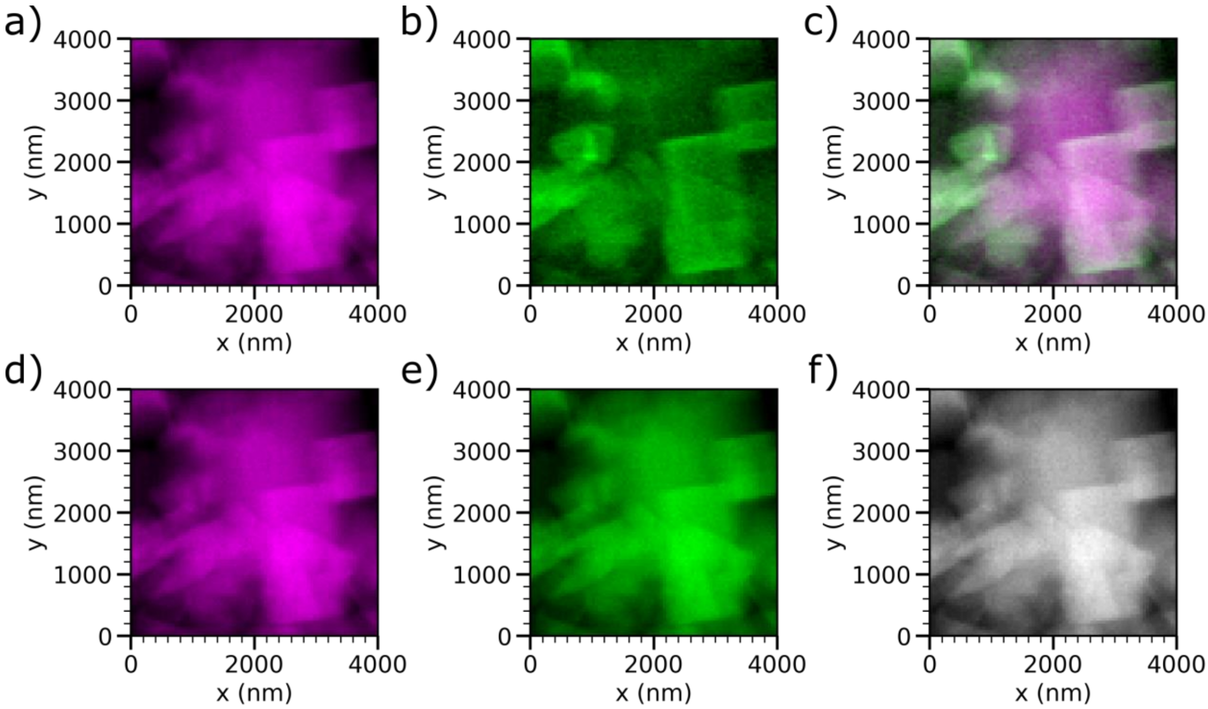

Figure S7. Image overlay. a) XRF map with a purple color scale. b) XBIC map of the same region as in (a) with a green color scale. c) Overlay of (a) and (b) obtained by summing the RGB vectors pixel by pixel. d) Same XRF map as in (a). e) Same XRF map as in (d) but with a green color scale. f) The result of the sum of (d) and (e).

We obtained the overlaid images by summing pixel by pixel the RGB vectors of the XRF and XBIC maps. The RGB vector is composed by three integer numbers, between 0 and 255, representing the relative intensity of red, green and blue composing the final colour of the pixel. Since we attributed purple to XRF maps and green to XBIC maps their respective RGB vectors are as follows:

$$\overrightarrow{XRF_i} = \begin{pmatrix} x_i \\ 0 \\ x_i \end{pmatrix}$$

$$\overrightarrow{XBIC_i} = \begin{pmatrix} 0 \\ y_i \\ 0 \end{pmatrix}$$

in which for XRF maps, the integers representing the intensity of red and blue are the same (x_i) in the i^{th} pixel; instead, for XBIC maps red and blue are set to zero and the green depends on the intensity of the signal in that specific pixel. x_i and y_i are equal to zero when the signal is the minimum and are set to 255 when the signal is the maximum. The sum of the two vectors is :

$$\overrightarrow{XRF_i} + \overrightarrow{XBIC_i} = \begin{pmatrix} x_i \\ 0 \\ x_i \end{pmatrix} + \begin{pmatrix} 0 \\ y_i \\ 0 \end{pmatrix} = \begin{pmatrix} x_i \\ y_i \\ x_i \end{pmatrix}$$

The resulting vector contains the colour information of the overlaid image. The pixel in which the XBIC signal is stronger than the XRF signal looks greener, on the contrary the pixels appears more purple. Figure S7a-c- show an example, taken from real raw data, of XRF purple map (figure S7a), XBIC green map (Figure S7b), and the sum of the two (Figure S7c). Instead, when the XRF and XBIC signals are equal (figure S7d,e) (same value in their relative scales) the resulting colour is a shade of grey (Figure S7f).