Supplementary Information

Atomic Characterization of Byproduct Nanoparticles on Cesium Lead Halide Nanocrystals using High-resolution Scanning Transmission Electron Microscopy

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More SAED results are illustrated in Figure S1, to further verify the existence of both $PbBr_2$ NPs and $CsPb_2Br_5$ NPs.

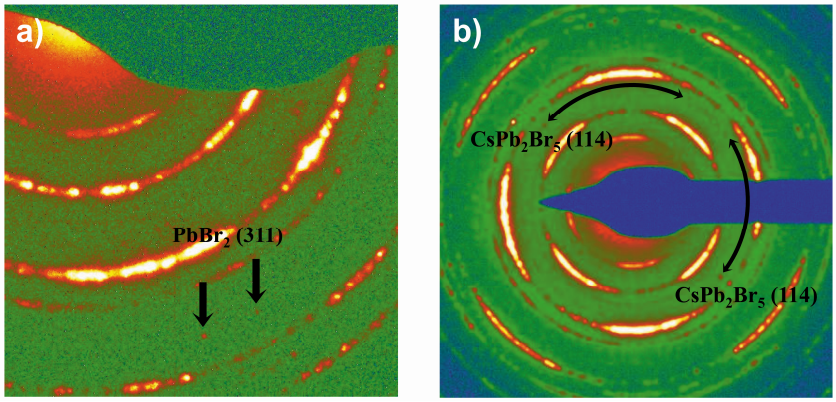

Figure S1. SAED patterns from two 0.48 μm^2 areas of the NPs on the $CsPbBr_3$ NCs. Arrowed spots and arcs can be identified as from $PbBr_2$ NPs and $CsPb_2Br_5$ NPs, excluding the main diffraction rings or arcs belonging to various $CsPbBr_3$ planes.

As shown in Figure S1a, excluding the bright diffractive rings belonging to various $CsPbBr_3$ planes, additional spots indicated with arrows can be indexed as $PbBr_2$ (311) plane. Also, in Figure S1b, additional spots and arcs indicated with arrows can be indexed as $CsPb_2Br_5$ (114) plane. Therefore, we finally prove the existence of both $PbBr_2$ and $CsPb_2Br_5$ NPs on the $CsPbBr_3$ NCs through SAEDs.

Table S1. Interplanar spacings of $CsPbBr_3$, $PbBr_2$ and $CsPb_2Br_5$ respectively

$CsPbBr_3$ (PDF#75-0412)				$PbBr_2$ (PDF#31-0679)				$CsPb_2Br_5$ (PDF#25-0211)			
d (Å)	I(f)	I(v)	hkl	d (Å)	I(f)	I(v)	hkl	d (Å)	I(f)	I(v)	hkl
5.874	43.1	21.6	1 0 0								
4.153	**98.3**	**69.5**	**1 1 0**	**4.105**	**56.0**	**40.0**	**1 2 0**				
3.391	21.2	18.4	1 1 1	4.032 3.751 3.102 3.081 3.071 2.958	31.0 73.0 50.0 55.0 56.0 23.0	22.0 57.0 47.0 52.0 53.0 23.0	2 0 0 1 1 1 1 2 1 2 2 0 2 0 1 1 3 0	3.800 3.700 3.210 3.040	10.0 25.0 20.0 100.0	8.0 21.0 19.0 100.0	2 1 0 2 0 2 1 1 4 2 1 3
2.937	**100.0**	**100.0**	**2 0 0**	**2.924**	**100.0**	**100.0**	**2 1 1**				
2.626	**18.5**	**20.7**	**2 1 0**	**2.641**	**90.0**	**100.0**	**0 3 1**	**2.685**	**45.0**	**51.0**	**3 1 0**
2.398	39.3	48.1	2 1 1								
2.076	64.1	90.6	2 2 0								

As shown in Table S1, most low index planes of $PbBr_2$ and $CsPb_2Br_5$ are overlapped with those of $CsPbBr_3$. Thus, in the SAED patterns, most diffractive signals from $PbBr_2$ and $CsPb_2Br_5$ are difficult to discern from the background of those from $CsPbBr_3$, leaving only few spots or weak arcs in between, which can be identified as from $PbBr_2$ and $CsPb_2Br_5$. Therefore, fewer diffraction spots corresponding to $PbBr_2$ and $CsPb_2Br_5$ are found in the SAED patterns compared with the large number of NPs observed in STEM-HAADF images.

EDS results of the NPs on a carbon film are illustrated in Figure S2 and Table S2, revealing the chemical information of the free NPs.

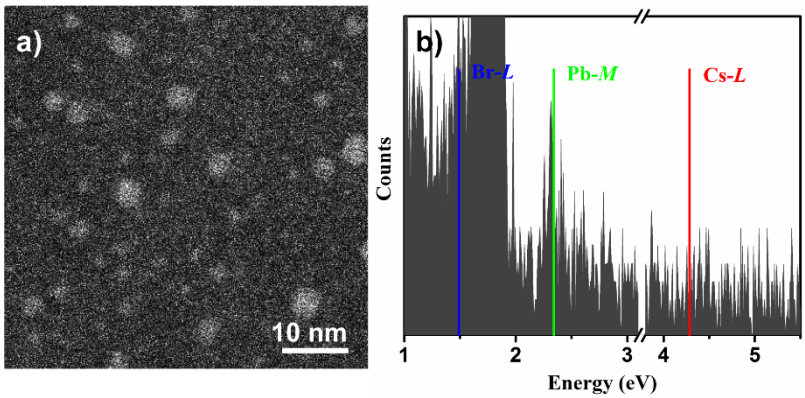

Figure S2. (a) A STEM-HAADF image of the NPs on a carbon film. (b) An integrated EDS spectrum acquired from the region as shown in (a).

Table S2. Atomic percentages of Cs, Pb and Br for a region with the NPs on a carbon film.

Element	Series	Norm. at. %
Cs	L	0
Pb	M	54.5
Br	L	45.5

As shown in Figure S2, both Br-*L* and Pb-*M* peaks can be clearly identified, whereas Cs-*L* peak is absent. Furthermore, quantitation has also been carried out and is shown in Table S2. Therefore, we conclude that the free NPs contain both Br and Pb, but lack Cs.