Supporting Information:

Doped Organic Hole Extraction Layers in Efficient PbS and $AgBiS_2$ Quantum Dot Solar Cells

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Supporting Figure S1: Absorption of PbS-PbX_2 QD film on glass.

Supporting Figure S2: TEM pictures of PbS-PbX_2 quantum dots.

Supporting Figure S3: XRD pattern of PbS-PbX_2 QDs.

Supporting Figure S4: PV parameters of PbS QD solar cell with PTAA only as HTL.

Supporting Figure S5: TEM overview picture of $AgBiS_2$ QDs.

Supporting Figure S6: XRD pattern of $AgBiS_2$-TMAI QDs.

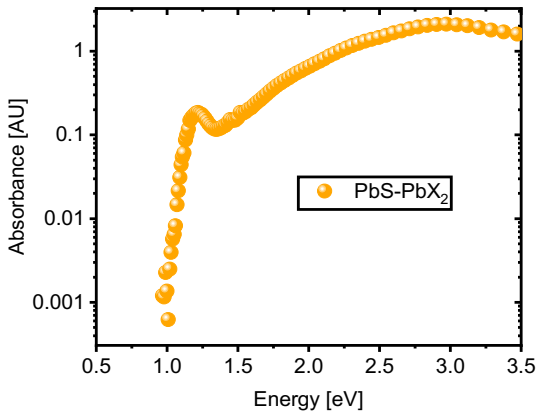
Supporting Figure S7: EQE data for $AgBiS_2$ QD solar cells with two different HTLs.

Supporting Figure S8: JV sweep for two typical $AgBiS_2$-TMAI QD solar cells with two different HTLs

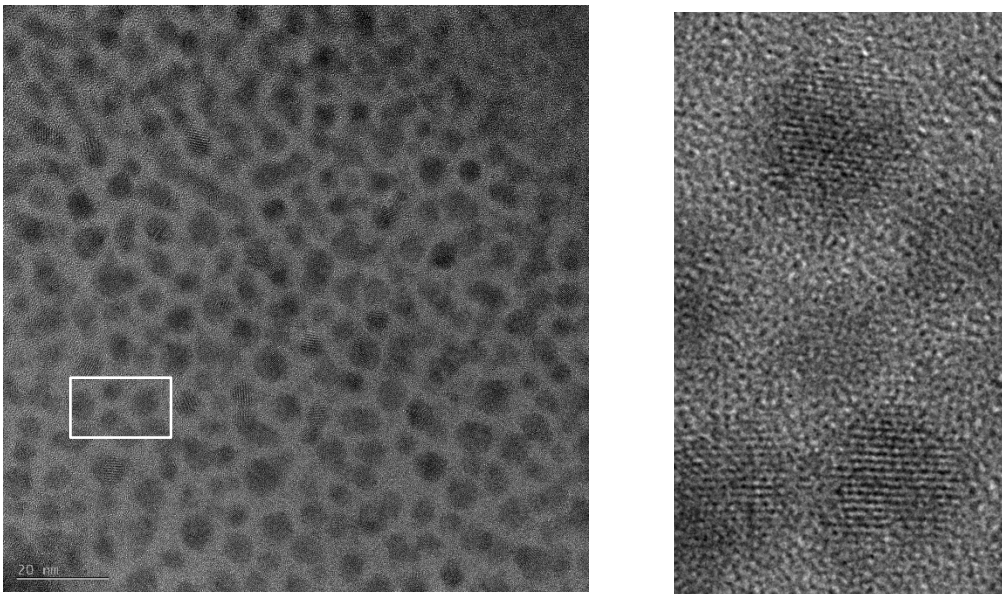
Supporting Table S1: Publications with modified HTL layer.

Supporting Figure S9: Absorption of pure and doped PTAA.

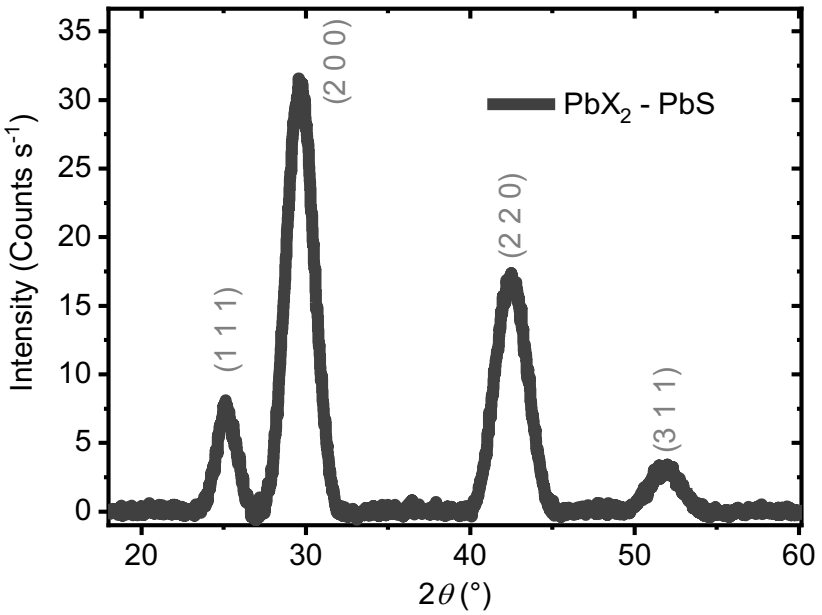
Supporting Figure S10: CV measurement of $C_{60}F_{48}$.



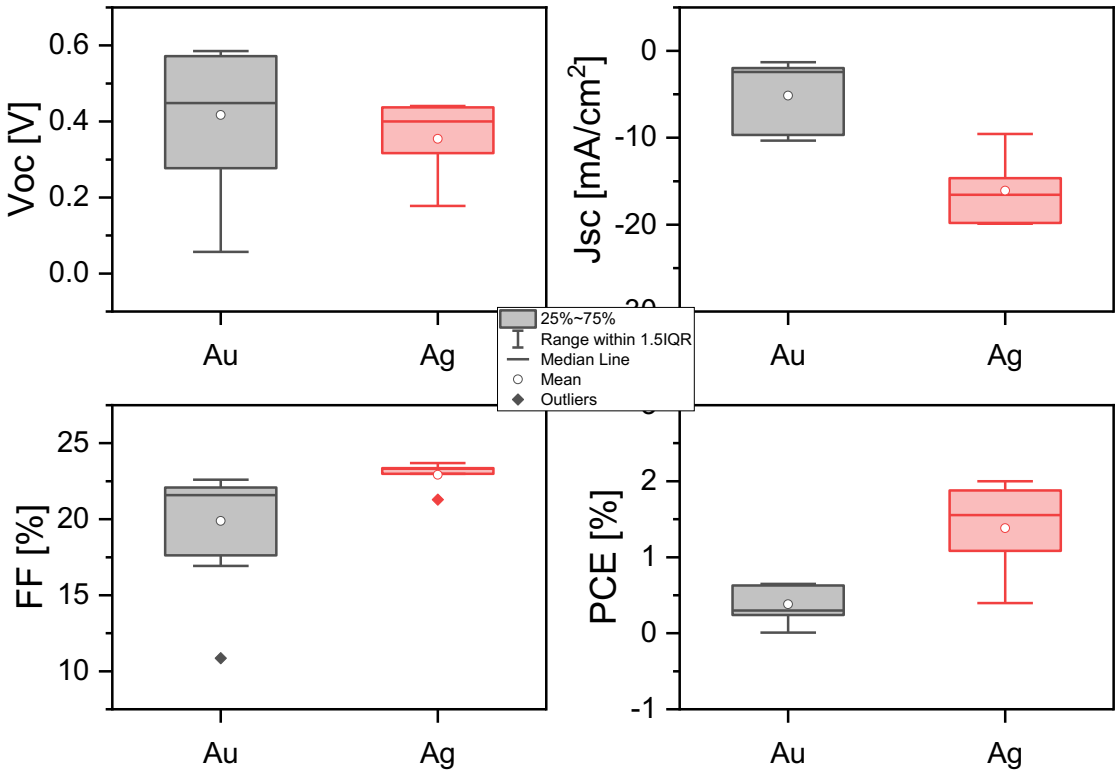
Supporting Figure S1: PDS measurement of a PbS-PbX_2 QD film on glass. The sharp band edge is an indicator for low electronic disorder and the first excitation peak lies at 1.2eV.



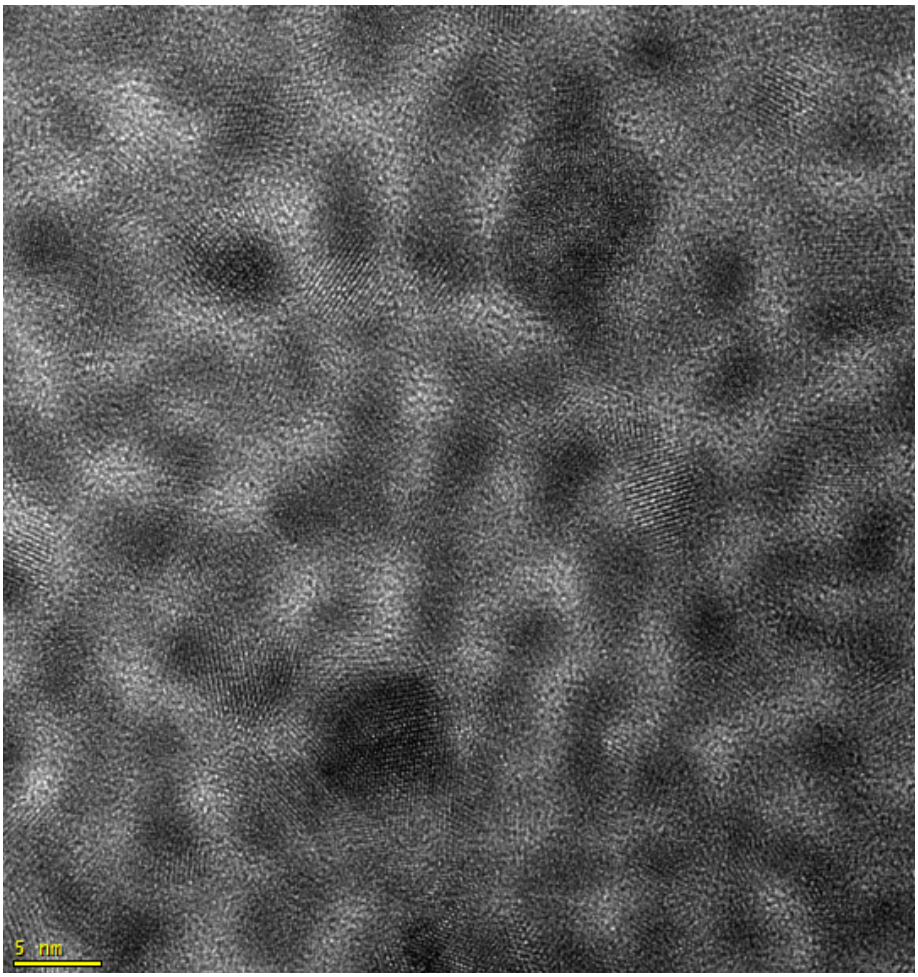
Supporting Figure S2: TEM pictures of PbS-PbX_2 QDs. a) Overview and b) zoom into the white frame of a)



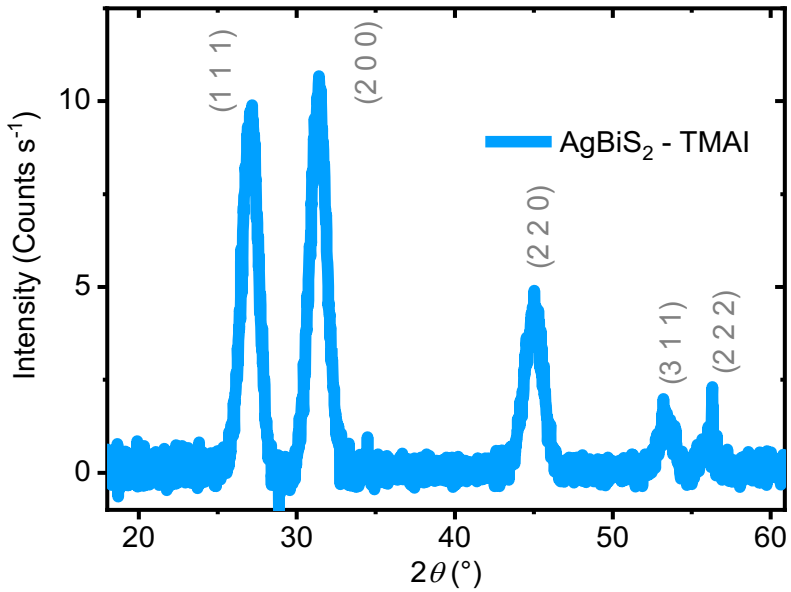
Supporting Figure S3: XRD pattern of a PbS-PbX_2 QD film drop casted on a silicon wafer.



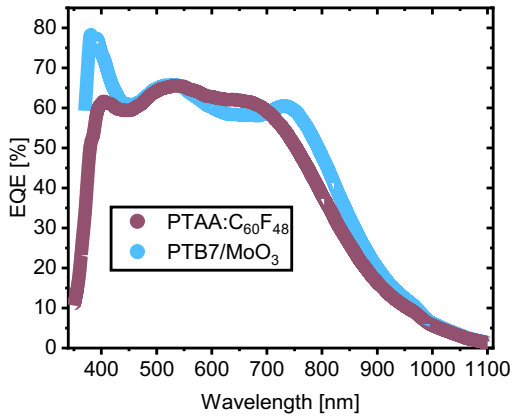
Supporting Figure S4: The PV characteristics of ITO/ZnO/PbS-PbX_2/PTAA/metal devices, without doping or MoO_3. Both, with Gold and Silver, no reasonable performance can be achieved.



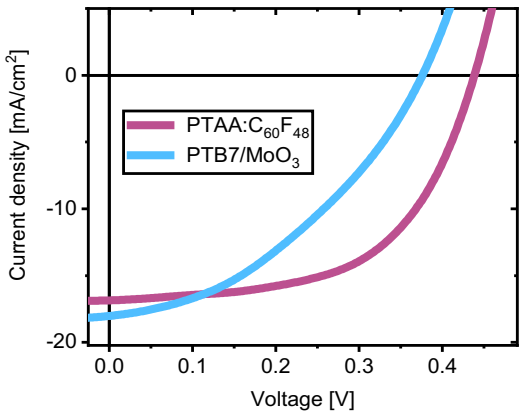
Supporting Figure S5: TEM overview over $AgBiS_2$ QDs.



Supporting Figure S6: XRD pattern of $AgBiS_2$-TMAI QD film drop casted on silicon wafer.



Supporting Figure S7: EQE data for characteristic $AgBiS_2$ QD solar cells with two different HTLs to calculate mismatch factors.

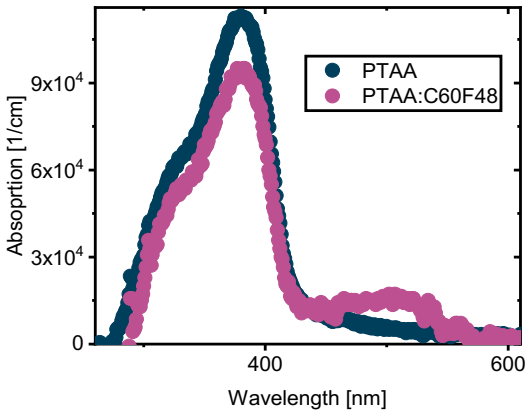


Supporting Figure S8: JV sweep of $AgBiS_2$-TMAI QD solar cells with two different HTLs.

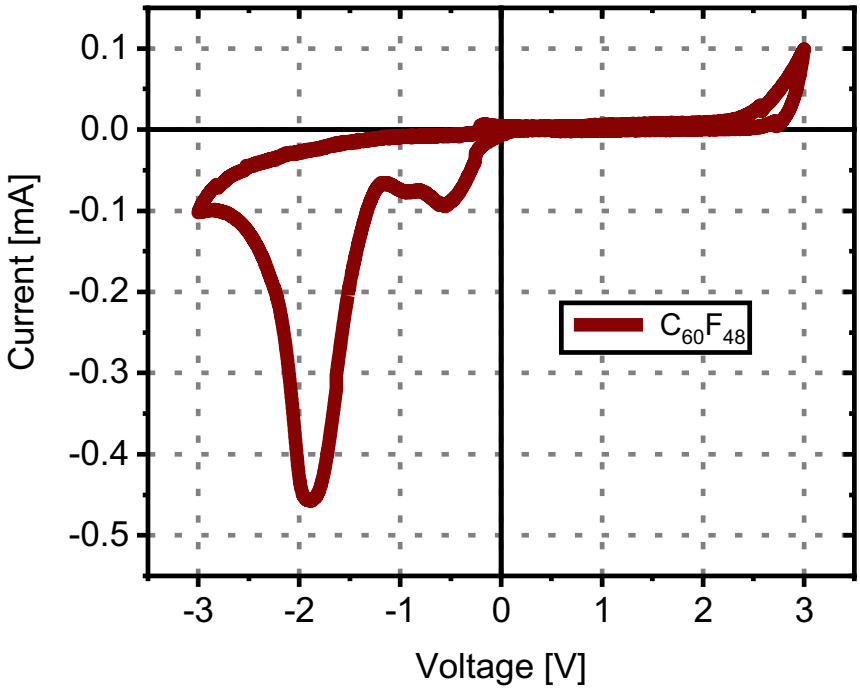
Supporting Table S1: Publications on modified HTLs.

Publication date	Device Architecture	PCE (%)	Reference
Organic extraction layers that contain MoO_3			
10.06.2011	ITO/ZnO/PbS-BDT/MoO_3/Au	3.5	*Nano Lett.* **2011**, 11, 7, 2955–2961
28.08.2012	ITO/ZnO/PbS-BDT/PCPDTTBTT/MoO_3/Ag	4.22	*Org. Electron.* **2012**, 13 (12), 2773
29.05.2018	ITO/ZnO/PbS-I/PTB7/MoO_3/Ag	9.6	*Adv. Energy Mater.* **2018**, 8, 23, 1800572
05.11.2019	ITO/ZnO/PbS-I/PBDB-T(S)/MoO_3/Ag	11.2	*ACS Energy Lett.* **2019**, 4, 12, 2850
11.11.2019	ITO/ZnO/PbS-I/PBDTTT-E_IEICO/MoO_3/Ag	13.1	*Nature Energy* **2019**, 4, 969
22.06.2020	ITO/ZnO/PbS-I/PTB7-Th:PCBM71/MoO_3/Ag	12.02	*ACS Energy Lett.* **2020**, 5, 7, 2335
03.09.2020	ITO/ZnO/PbS-I:PbS-thiol/x-PBTBDT/MoO_3/Ag	13.2	*Adv. Energy Mater.* **2020**, 10, 39, 2002084
15.10.2020	ITO/ZnO/PbS-I/TIPS-TPD/MoO_3/Ag	13.03	*ACS Energy Lett.* **2020**, 5, 11, 3452–3460
MoO_3-free organic extraction layers			
11.06.2015	ITO/PEDOT:PSS/PbS-BDT:P3HT/LiF/Al	1.98	*J. Phys. Chem. C* **2015**, 119, 27, 14972
10.09.2015	FTO/TiO2/PbS-3MPA/PTAA:Li-TFSI/Au	1.7	*J. Mater. Chem. A* **2015**, 3, 20579

10.09.2015	FTO/TiO2/PbS-3MPA/P3HT:Li-TFSI/Au	5.09	*J. Mater. Chem. A* **2015**, 3, 20579
19.04.2016	ITO/ZnO/PbS-I/P3HT/Au	7.5	*ACS Appl. Mater. Interfaces* **2016**, 8, 19, 12101
10.01.2018	FTO/Zr-TiO2/PbS-I/P3HT:Li-TFSI/Au	7.8	*IEEE Journal of Photovoltaics* **2018**, 8, 2, 493
30.10.2019	ITO/ZnO/PbS-TBAI/a-6T/PEDOT:PSS/Au	9.2	*Adv. Energy Mater.* **2019**, 8, 48, 1901938
2021	ITO/ZnO/PbS-I/PTAA:$C_{60}F_{48}$/Au	10.41	This work



Supporting Figure S9: Absorption measurements of pure and 50%mr doped PTAA clearly showing the polaron absorption.



Supporting Figure S10: Cyclic voltammetry (CV) measurement of $C_{60}F_{48}$ spin-coated thin film on ITO substrate.