

University of Groningen

5.2% efficient PbS nanocrystal Schottky solar cells

Piliago, Claudia; Protesescu, Loredana; Bisri, Satria Zulkarnaen; Kovalenko, Maksym V.; Loi, Maria

Published in:
Energy & Environmental Science

DOI:
[10.1039/c3ee41479e](https://doi.org/10.1039/c3ee41479e)

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2013

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Piliago, C., Protesescu, L., Bisri, S. Z., Kovalenko, M. V., & Loi, M. A. (2013). 5.2% efficient PbS nanocrystal Schottky solar cells. *Energy & Environmental Science*, 6(10), 3054-3059. DOI: 10.1039/c3ee41479e

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

Supporting Information

5.2% Efficient PbS Nanocrystal Schottky Solar Cells

*By Claudia Piliago,[†] Loredana Protesescu,[‡] Satria Zulkarnaen Bisri,[†] Maksym V. Kovalenko,[‡]
and Maria Antonietta Loi^{†*}*

[†]Zernike Institute for Advanced Materials, University of Groningen, Nijenborgh 4, Groningen,
9747 AG, The Netherlands

[‡]Department of Chemistry and Applied Biosciences, ETH Zürich, Wolfgang-Pauli-Str. 10,
Zurich, 8093 and EMPA-Swiss Federal Laboratories for Materials Science and Technology,
Überlandstrasse 129, Dübendorf, 8600, Switzerland.

Email: m.a.loi@rug.nl

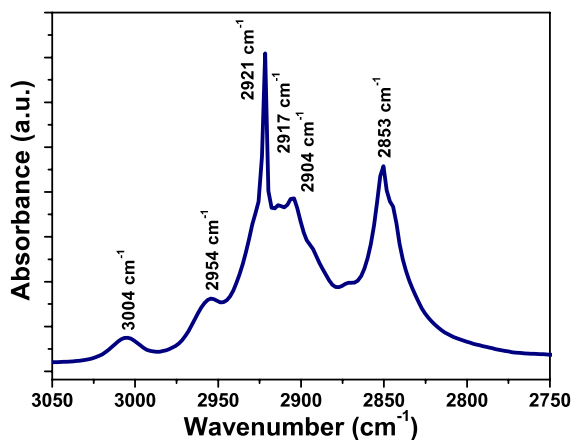


Figure S1. FTIR spectra for *PbS_3* washing steps: the peaks at 2921 cm⁻¹, 2917 cm⁻¹, 2904 cm⁻¹ and 2853 cm⁻¹ are assigned to antisymmetric and symmetric methylene stretch modes ($\nu_{(as)}\text{CH}_2$, $\nu_{(s)}\text{CH}_2$).

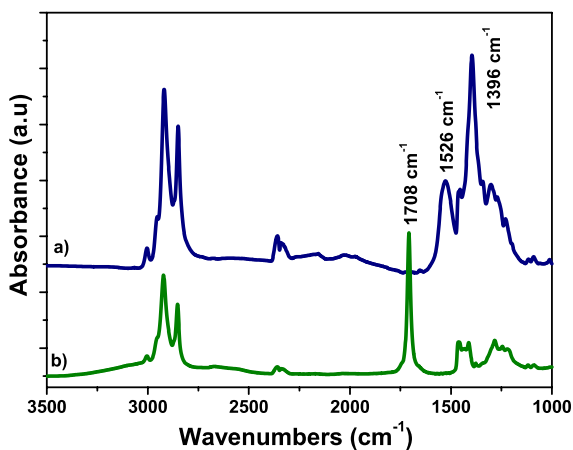


Figure S2: FTIR spectra for a) *PbS_4* washing steps the wavenumbers separation between $\nu_{as}(\text{COO}^-)$ -1526 cm⁻¹ and $\nu_s(\text{COO}^-)$ -1396 cm⁻¹ is 130 cm⁻¹ and it can be assigned to a bidentate coordination. b) Oleic acid: the peak at 1708 cm⁻¹ corresponds to the C=O stretching of carboxylate in acidic form.

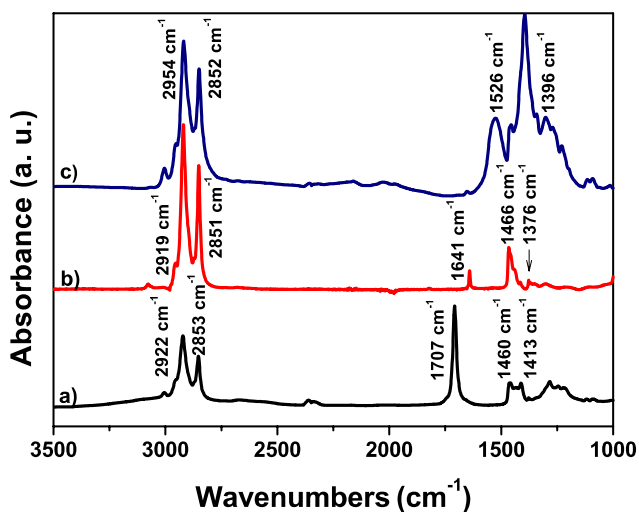


Figure S3. FTIR spectra for *a) oleic acid*: 2922 cm⁻¹ -v_{as}(C-H in CH₂ and CH₃), 2853 cm⁻¹ -v_s(C-H in CH₂), 1707 cm⁻¹ v(C=O)-acidic form, 1460 cm⁻¹, 1413 cm⁻¹ - δ(C-H in CH₂)-bending and scissoring vibration mode, *b) octadecene*: 2919 cm⁻¹ -v_{as}(C-H in CH₂ and CH₃), 2851 cm⁻¹ -v_s(C-H in CH₂), 1641 cm⁻¹ v(C=C)-, 1466 cm⁻¹ v(C-H in CH₂)-bending vibrations, 1376 cm⁻¹ umbrella type of vibration, *c) PbS 4 washing steps*: 2954 cm⁻¹ -v_{as}(C-H in CH₂ and CH₃), 2852 cm⁻¹ -v_s(C-H in CH₂) v_{as}(COO⁻)-1526 cm⁻¹ and v_s(COO⁻)-1396 cm⁻¹.

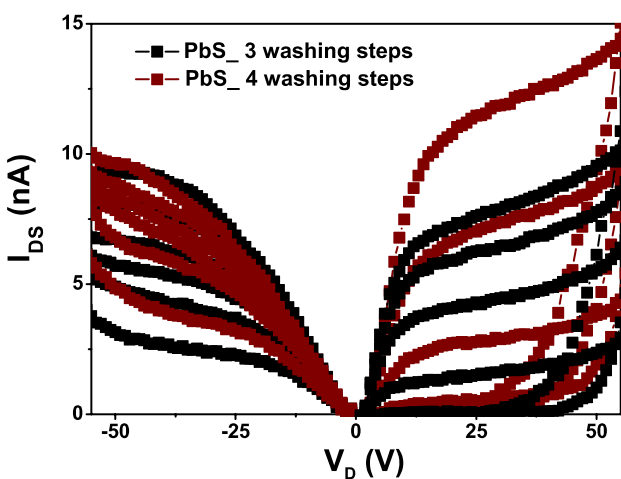


Figure S4 p-channel and n-channel I_D - V_D output characteristics of FETs of PbS colloidal nanocrystal fabricated using solutions with 3 and 4 washing steps. The electron mobilities, extracted from the transfer curves in saturation regimes are: *PbS_3 washing steps* $1.2 \times 10^{-5} \text{ cm}^2/\text{Vs}$ and *PbS_4 washing steps* $2 \times 10^{-5} \text{ cm}^2/\text{Vs}$.

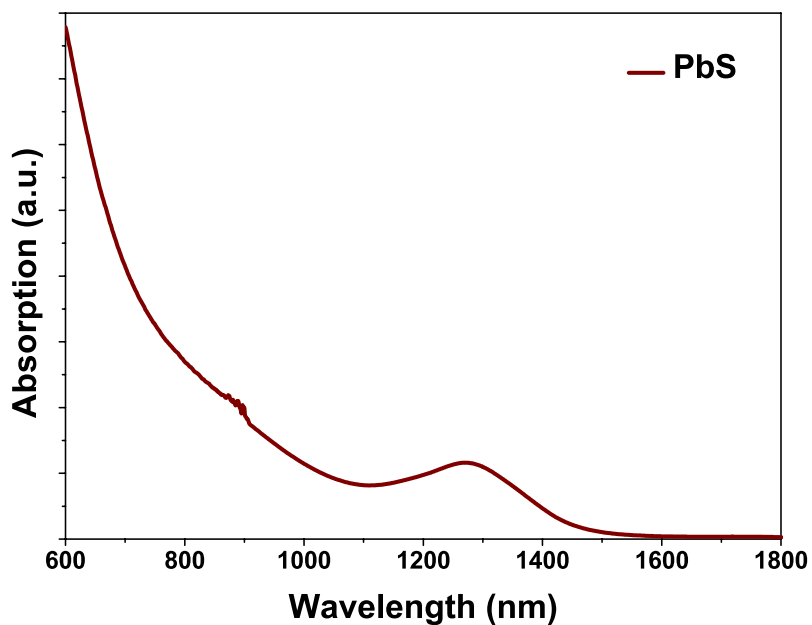


Figure S5 Absorption spectra of OA-capped PbS nanocrystals dispersed in chloroform.

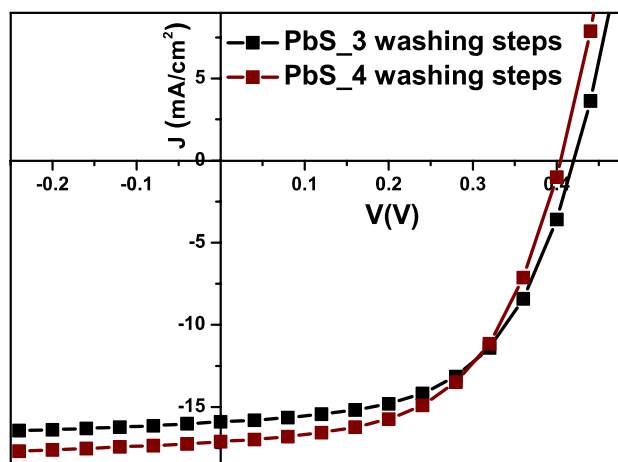


Figure S6 J - V current-voltage characteristics of the devices realized from PbS solutions with 3 and 4 washing steps.

Table 1. Comparison of performance parameters between solar cells fabricated from the solutions of PbS nanocrystal that have been washed three times and four times

	V_{oc} (V)	J_{sc} (mA/cm²)	FF (%)	PCE (%)
PbS_3 washing steps	0.42	-15.9	55	3.7
PbS_4 washing steps	0.4	-17.2	55	3.8