Fast and Sensitive Solution-Processed Visible-Blind Perovskite UV Photodetectors

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MAPbCl$_3$ thin film fabrication$^{[11]}$: Lead precursor [PbCl$_2$] and methylammonium chloride were weighed and added together in a vial such that the molar ratio of lead to halide was 1:3. Solvent was then added to the powder precursors. Dimethyl sulfoxide (DMSO) was used as the solvent and the concentration of Pb$^{2+}$ was 0.6 M. Solutions were vortexed and then sonicated for 20 min. 150 μL of solution were deposited on clean substrates for spin-coating. Samples were spun at 4000 rpm for 1 minute. Samples were immediately annealed for 45 minutes at 100 °C on a hotplate. The entire fabrication procedure was performed in a room-temperature nitrogen atmosphere.
SEM images of the MAPbCl$_3$ crystalline films: top view, side views, and close-up on single crystals junctions.
Figure S2: Hall mobility data

Nanometrics HL5500 Hall System
Measured on 10/26/15 at 5:40 PM

SPECIMEN
Wafer ID:
Batch ID:
Material: MAPbCl₃
Description:
Thickness: 1000.000 µm

MEASURING CONDITIONS
I-meas: 0.7 nA DC
Temperature: AMB
Field: 0.504 Tesla
Targ.Vr: 20 mV

RESULTS SUMMARY
Rs: 9.937e+07 ohm/sq
R: 9.937e+06 ohm-cm
Rh: +2.58e+05 m²/C
N: +2.419e+09 /cm²
Mob: 26 cm²/V-s

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RESISTIVITY
Meas Vm Sym Factor R-sheet
43 +6.861e-02 +2.360e-02 2.29 0.94 9.898e+07
41 -1.257e-03 -2.096e-02 1.81 0.97 8.894e+07
21 +5.836e-02 +2.149e-02 1.48 0.99 9.938e+07
23 +1.217e-01 +9.659e-02 1.80 0.97 1.102e+08

HALL MEASUREMENTS
M慈善ment +5.72e-02 +4.19e-02 +3.89e-02 +6.32e-02
Offset applied -6.67e-03 +1.00e-02
V-hall North +4.51e-02 +4.33e-02 +4.18e-02 +4.46e-02
V-hall South +3.84e-02 +3.71e-02 +3.32e-02 +3.63e-02
V-hall (mean) +1.07e-04 +7.55e-05
V-hall (over all cycles) +9.10e-05

Datasheet of the Hall effect measurement, performed with a Nanometrics HL5500 Hall system. The resistivity is measured using the 4-probes technique. The semiconductor is shown to be p-type, exhibiting a positive Hall effect coefficient RHS. The value of the holes mobility is 26 cm²/Vs. The concentration of free carriers is measured in the order of n_free = ~ 10¹⁰ cm⁻³. The measurement was performed under the following conditions: magnetic field intensity (0.504 T), temperature (300.6 K), target voltage (20 mV). The Nanometrics HL5500 was set up in a configuration including a current amplifier to remedy the high resistivity of the sample. The samples were contacted using MoO₃/Au/Ag contacts.
The absorption spectrum of the full detector (Glass/ITO/MAPbCl$_3$) was measured using the procedure described in the Methods and shows the transparency of the device across the visible spectrum.
Figure S4: Performance comparison of thin-film MAPbCl$_3$ photodetectors. Photocurrent, responsivity and time response of fabricated thin-film photodetectors.

Thin film detectors were fabricated via spin-coating of precursor solution (as used for PL measurements). Responsivity, photocurrent and time response of the best device are shown in Figure S4. Compared to the single crystal photodetectors, the thin film devices show a decrease of more than two orders of magnitude in photocurrent and responsivity, and a 20-times slower response.
Figure S5: Stability in air and N\textsubscript{2}. a) Dark current measured in controlled N\textsubscript{2} atmosphere and air. b) Photocurrent in air normalized to photocurrent in controlled N\textsubscript{2} atmosphere.

Electrical characterization was performed on detectors placed in air and in a controlled N\textsubscript{2} environment. Only a slight decrease in performance was observed when the devices were placed in air, as seen in Figure S5a-b. Measurements were done using the procedure described in the Methods, using a Hewlett Packard 4156A Precision Semiconductor Parameter Analyzer when done in air.