Research Center for Photovoltaics

Hybrid quantum dots perovskites solar cells

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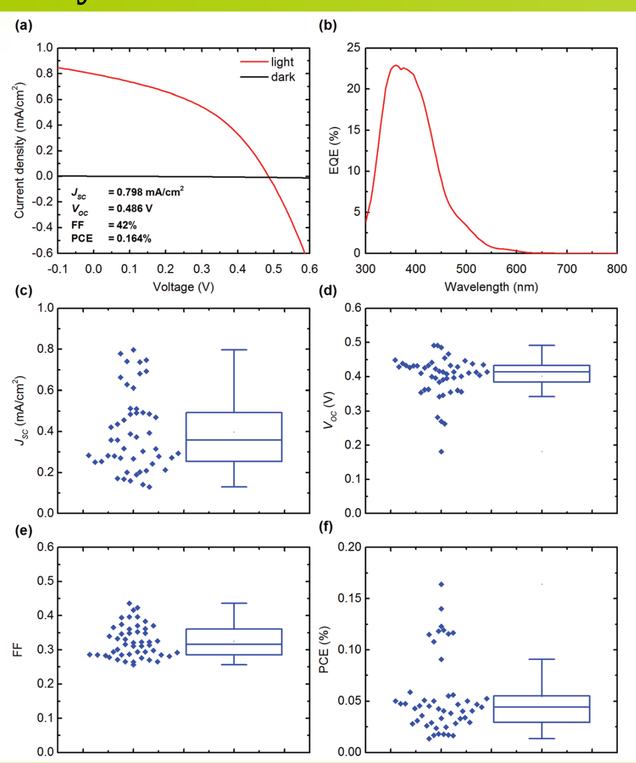
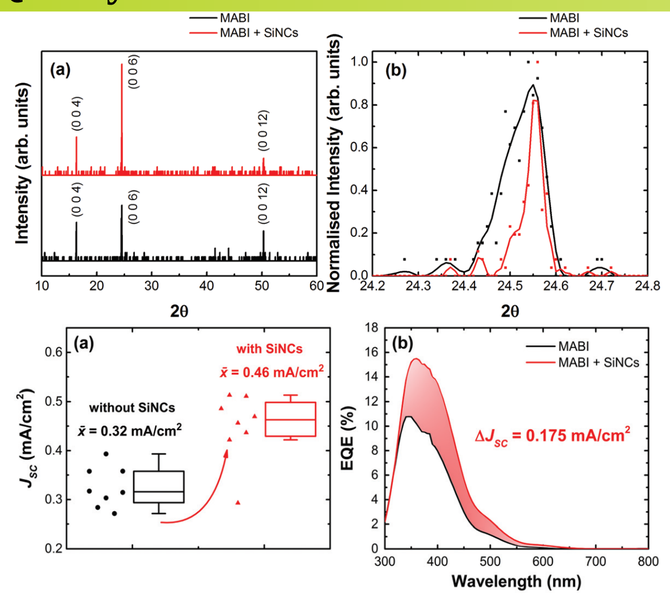
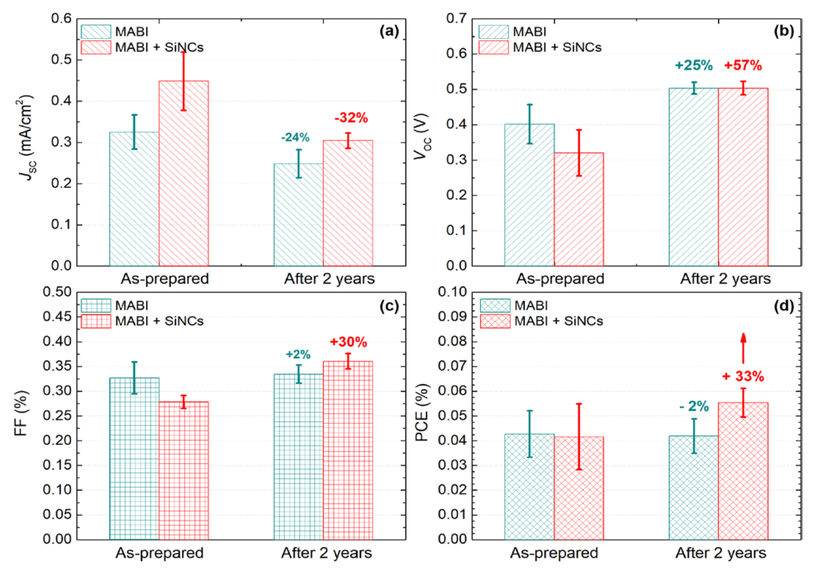
Motivation

- Silicon (Si) abundant and non toxic material.
- Significantly enhanced efficiency of solar cells with doped Si nanocrystals with quantum confinement (< 10 nm).
- Colloidal surfactant free Si quantum dots (Si QDs) based hybrids → easy to introduce to solution process.
- Methylammonium iodo bismuthate $(CH_3NH_3)_3(Bi_2I_9)$ MABI /Si QDs hybrids → non toxic material however low efficiency.
- Methylammonium lead iodide ($CH_3NH_3PbI_3$) perovskite MAPI / Si QDs hybrids → Pb toxic element.

Methylammonium iodo bismuthate / Si QDs hybrids

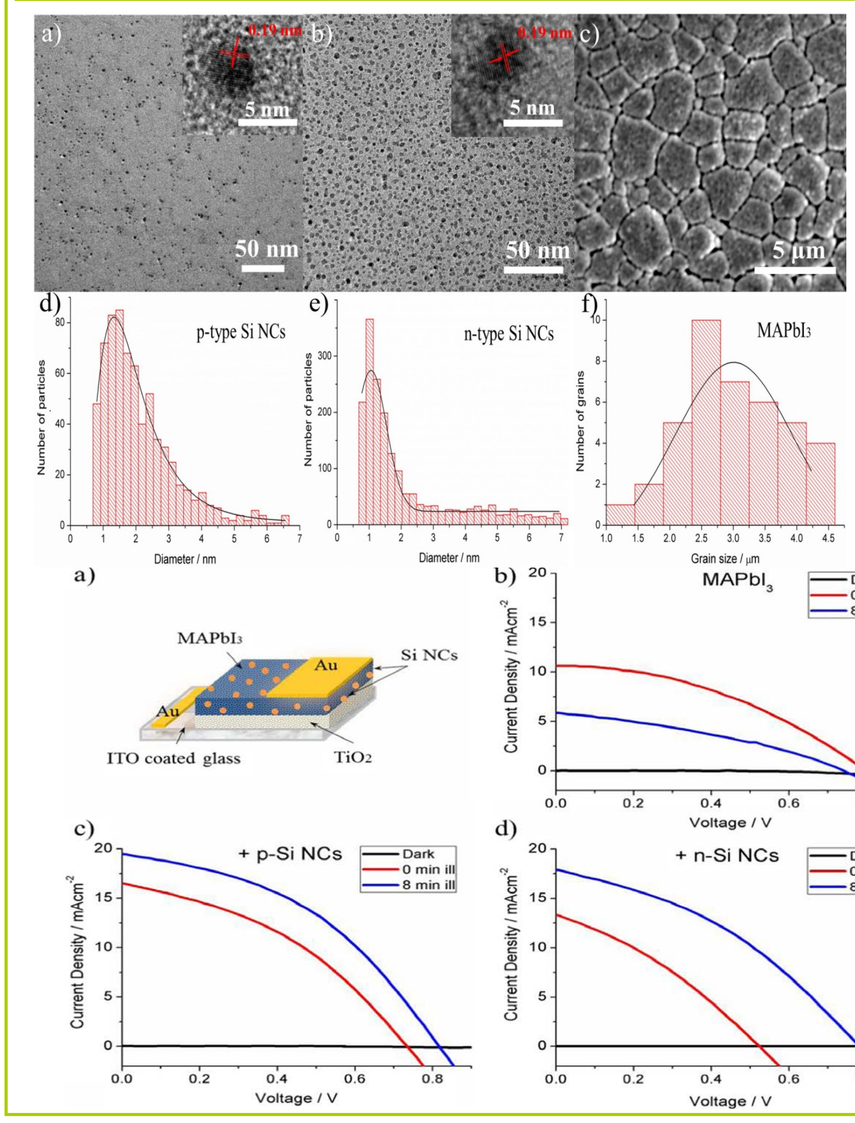




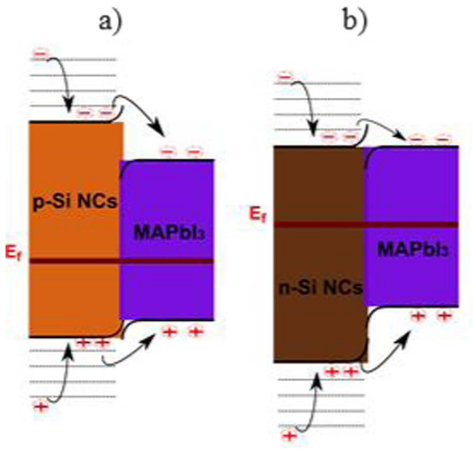


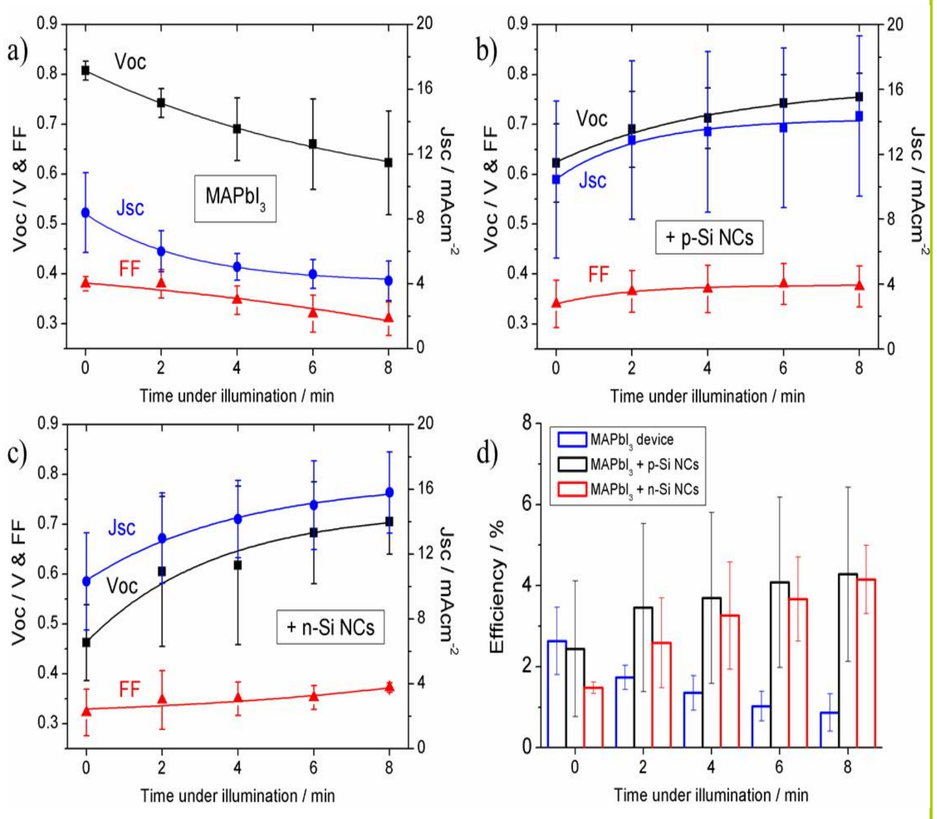
- X-ray diffraction pattern for MABI is highly orientated in the [001] direction.
- The MABI / SiNCs narrowing in XRD → increased crystal quality.
- Main increase in photocurrent generation is observed.
- Enhanced performance (> 30%) and stability with Si NCs after 2 years storage at ambient conditions.

Methylammonium lead iodide perovskite / Si QDs hybrids



Heterojunction with type-I alignment





- Doped surfactant free Si QDs blended with methylammonium lead iodide.
- Solar cell performance increased with the presence of the Si QDs.
- Type-I alignment → charge transfer occurring between the two semiconductors.
- Water absorption and transport enhanced.

Conclusions

- Perovskites hybrids based with surfactant free and colloidal dispersible Si QDs.
- Methylammonium iodo bismuthate MABI / Si QDs solar cells.
- Methylammonium lead iodide MAPI / Si QDs solar cells.
- In both cases an improvement in photocurrent generation, stability and an enhancement the endurance against light irradiation (1 sun) at ambient conditions is recorded.