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Abstract:

Hybrid Halide Perovskite are probably the current hottest materials for photovoltaics due to several reasons. Certified photoconversion efficiencies as high as 20.1%\textsuperscript{1} has been reported. Efficiencies in all-solid devices has moved from 10-11%\textsuperscript{2,3} to this impressive 20.1% in less than three years. In addition, Perovskite Solar Cells (PSCs) can be prepared from solution methods at low temperature, and consequently they can be fabricated without large and expensive facilities. These facts are causing that a large number of researchers been attracted by the research in this field. Thus many researchers working on dye sensitized solar cells, organic or quantum dot solar cells are currently working on PSCs, contributing to a large number of papers and consequently of advancement.

Nevertheless, many of the improvements obtained have been achieved by the refinement of the deposition techniques and there are several aspects of this new technology that are not completely understood. In fact three main limitations can be currently detected in PSCs: incomplete knowledge of the solar cell working principles, Pb content and relatively low stability. A systematic characterization of perovskite materials and PSCs will undoubtedly contribute to improve our understanding of these materials and devices and it will contribute directly to analyze and solve the other main problems. In my talk, I will focus on the characterization of PSC. From this characterization some conclusions but also many questions can be extracted, indicating that PSCs constitute a new and independent group of photovoltaic devices but also that they exhibit unconventional properties that have not been previously observed in other kind of photovoltaic materials.

In order to clarify some controversy coming from the first days of the PSCs technology,\textsuperscript{2} concerning the role of the PbCl\textsubscript{2}, we have prepared PSC with non-halide Pb precursors obtaining solar cells with significant efficiency, especially in the case of lead acetate precursor with efficiencies as high as in the case of using PbCl\textsubscript{2}. Lead halide are not needed for the preparation of PSCs but the kind of precursor used has a big influence in the final PSC performance and also in the device stability.\textsuperscript{4} It is also interesting to highlight that not only perovskite is affecting the device performance, and also the most common hole transporter material employed in PSCs, is affecting this stability.\textsuperscript{5}
Another interesting aspect of perovskite solar cells are the unconventional properties that have been detected. We have observed a photoinduced giant dielectric constant, see Fig. 1.\(^6\) How this effect is related with the high PSC performance and the physical origin of the effect is under evaluation. The physical origin probably is due to a polarization effect induced by structural changes in the perovskite and/or ion migration.

In order to obtain more clues on the PSC behavior we have characterized samples using different characterization techniques as J-V curves, impedance spectroscopy, photopotential decays, photoinduced absorption and time-resolved photoluminescence. With these techniques we have studied important PSC aspects as the role of selective contact, hysteresis, effect of the solar cell configuration (thin film or nanostructured devices), or injection into the nanostructured TiO\(_2\) layer. Interesting conclusions can be extracted from these studies but also interesting question have arisen that are looking for appropriate answers. PSC probably will provide us with more surprises in addition to its spectacular efficiencies.

![Fig. 1: Real permittivity vs. frequency for different incident light intensity from dark to 1sun, for MAPbI\(_3\) perovskite](http://www.nrel.gov/ncpv/images/efficiency_chart.jpg)

**References**