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Hybrid perovskite has rapidly emerged as a promising candidate for the next generation photovoltaics with power conversion efficiencies (PCEs) up to 25.2%[1]. Compared to commercial silicon-based solar cells, it is price competitive (Perovskite: 40 $/m2 < Silicon: 80$/m2) thanks to the simple process and cheap materials. Although these advantages are competitive, the electrical instability of the device due to ion migration, that is, hysteresis, is an issue of Perovskite Solar Cells (PSCs)[2].

We have observed phenomena caused by ion migration within a ITO / PEDOT:PSS / Perovskite / PCBM / Ag structured PSC device in various approaches. Using the GD-OES, mobile ions that move noticeably were identified, and mobile ions and even fixed ions were observed from a relative quantitative point of view[3]. Additionally, we confirmed that ions contribute to electric conduction according to the applied electric field in dark conditions beyond 263K[4].

We studied which physical parameters are changed at the interface. The increase of mobile ions by ageing can contribute to make additional capacitance at the interface. The Impedance Spectroscopy (IS) can be a tool to show the coherent between quantity of mobile ion and internal circuit change. In particular, the IS analysis of the medium frequency (MF) and low-frequency (LF) region allows to investigate phenomenon at the interface caused by ion migration[5]. By focusing MF, LF region analysis, we observed additional RC circuit formation by ageing.

As a result, we observed additional parallel RC circuit (C= 0.6MF, R= 2.6MΩ) after 3 days. This result is the discovery that the aging phenomenon that increases mobile ions creates a relatively large capacitor and resistance.

Keywords & Abbreviation: Perovskite Solar Cells (PSCs), ion migration, Impedance Spectroscopy (IS)

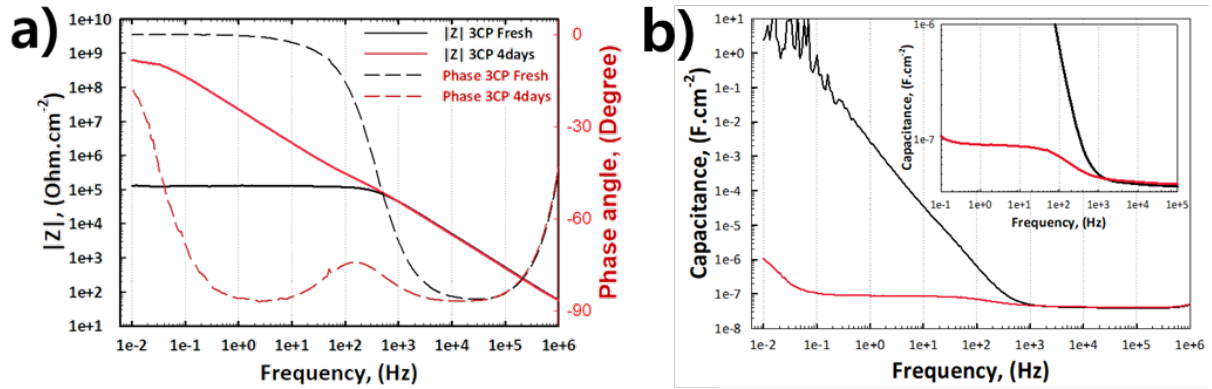

Figure. 1 Summary of IS results a) Bode plot, b) cap. vs Freq. curve comparing fresh PIN device and 4days aged in air and dark condition.

REFERENCES
1. NREL. Best efficiency chart (2020).
2. Park et. al. Nat Energy, 1, 16152 (2016)
3. H. Lee, et al., ACS Energy Lett. 2, 943-949 (2017)
4. H. Lee, et al. J. Phys. Chem. C 123, 17728–17734 (2019).
5. A. Todinova, et al. ChemElectroChem 4, 2891 – 2901 (2017).