

FERROCENE DERIVATIVES AS UNIVERSAL ADDITIVES FOR PEROVSKITE SOLAR CELLS

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Metal halide perovskites are leading candidates for next-generation photovoltaic technologies due to their high power conversion efficiencies (PCEs), low-cost processing, and tunable bandgaps suitable for both single-junction and tandem architectures.^[1,2] Nevertheless, challenges associated with large-area uniform crystallization, defect control, and long-term operational stability continue to hinder their translation from laboratory-scale devices to industrial platforms.^[3] Here we demonstrate that targeted functionalization of ferrocene enables systematic molecular-level tuning of perovskite surface passivation and work function modulation, enabling improved charge regulation, reduced defect densities, and enhanced operational stability. Building on our initial study using ferrocenyl-bis-thiophene-2-carboxylate,^[4] our next-generation derivatives deliver exceptional PCEs exceeding 26% in perovskite solar devices, alongside outstanding long-term operational stability in both small- and large-area devices.^[5,6] These findings highlight the chemical versatility of ferrocene derivatives as a modular platform for interfacial engineering in perovskite materials and demonstrate their potential as universal additives for next-generation perovskite optoelectronic technologies.

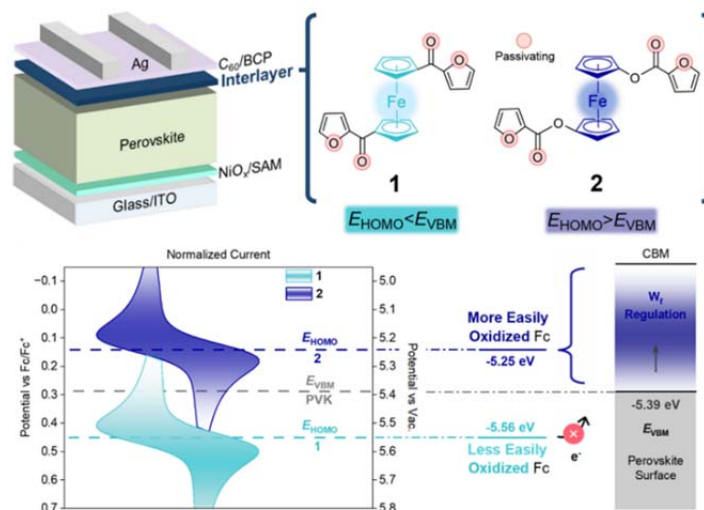


Figure 1. Rational tunability of ferrocene derivatives to passivate surface defects and modulate work function.

[1] *Nat. Rev. Methods Primers*, **2025**, *5*, 3

[2] *Nat. Photon.*, **2026**, *20*, 11-23

[3] *Nat. Rev. Mater.*, **2026**, *11*, 10-25

[4] *Science*, **2022**, *376*, 416-420.

[5] *J. Am. Chem. Soc.*, **2024**, *146*, 13391-13398

[6] *Angew. Chem. Int. Ed.*, **2025**, *64*, e202424041