# How to extract hot carriers from perovskite nanocrystal by fullerenes: forming state-coupled complexes

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## Abstract

Utilizing hot carriers (HCs) is the crucial approach for solar cell to exceed the thermodynamic detailed balance limit, yet effective extraction of hot carriers in absorber materials via most commonly used semiconductor acceptors has been a challenge in both materials and photophysics research for many years. Herein, we build series of $CsPbI_3$ nanocrystal (NC) and fullerene systems to explore the decisive factors of this process and realized efficient hot carrier extraction in these systems (maximum extraction efficiency ~ 84%). We find building the systems as state-coupled complexes creates new carrier transport channels at about 0.22 eV above $CsPbI_3$ NC bandgap, which facilitates highly efficient HC extraction. Our research directly visualizes the inner connection of molecule interaction and ultrafast hot carrier dynamics. The knowledge and strategy gained here are of universal meaning, taking an important step forward true hot carrier photovoltaics.

## Discussion

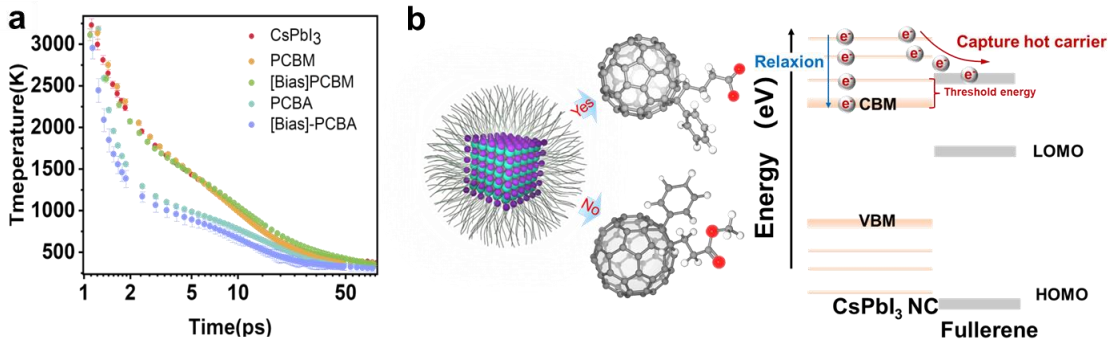


Figure (a). Time-dependent HC temperature ($T_c$) decay of $CsPbI_3$ NC and series of $CsPbI_3$ NC-fullerene hybrids. (b) Schematic diagram of HC extraction from perovskite nanocrystal to fullerene.

## Conclusion

Our research suggests that chemical bonding, electronic coupling, and carrier transfer are symbiotic each other. These findings gained here are essential for advancing the development of new optoelectronics.