Excited-State Electron Transfer of Molecules: Tale of Degradation in Electroluminescence Devices

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Abstract

The exploitation of the full potential of organic electroluminescence devices (OLEDs) has been retarded by the short operation time. The poor longevity originates from irreversible degradation of organic materials. However, the chemical mechanism by which degradation initiates has yet to be fully understood to date. My group proposed that the degradation involves exciton-mediated formation of a radical ion pair between wide bandgap-energy hosts and phosphorescent dopants within emitting layers.1 To examine this hypothesis, we performed mechanistic studies with employing chemical techniques. Electrochemical studies predicted an occurrence of reductive electron transfer from a dopant to host exciton to form a radical ion pair of dopant radical cation and host radical anion. A variety of spectroscopic techniques were employed to directly monitor the generation and annihilation of the radical ion pair. In particular, we found that the annihilation occurred in the Marcus-inverted region of electron transfer. The charge recombination competed with chemical degradation, and our analyses of degradation byproducts indicated an occurrence of C-N bond breakage of both host and dopant molecules. Finally, a linear correlation was found between device lifetimes and rate constants for the annihilation of the radical ion pair. This result supports our mechanism which involves the exciton-mediated generation of labile radical ion species. Our findings demonstrate the importance of controlling exciton-induced electron transfer within an emitting layer, and provide novel molecular strategies to improved device longevity.

Keywords: *electron transfer, electroluminescence, degradation*

References

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Biography

Youngmin You received his B.S. (Cum Laude) and M.S. degrees in Chemical Engineering from Seoul National University, Korea. He earned his Ph.D. degree in Materials Science and Engineering at SNU in 2007. He joined Ewha Womans University as an assistant professor in 2015, and was promoted to associate professor in 2017. His research interests include the discovery, understanding, and creation of new photofunctional molecules.