Air-Stable Benzimidazoline n-Type Dopants for Conductive Host Materials with Low Electron Affinities

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Nowadays a growing interest is devoted to molecular reductants for solution-processable organic semiconductors such as organic light-emitting diodes (OLEDs), organic photovoltaics (OPVs), thermoelectric generators (TEGs), organic field-effect transistors (OFETs), and circuitry in which they can increase the conductivity, reduce bulk ohmic losses and/or decrease carrier-injection barriers.[1] They can also modulate the work function (WF) of inorganic electrode materials and push the performance of inverted perovskite solar cell by boosting the conductivity of PCBM type ETMs. However, the availability of high-performance and air-stable solution-processable n-doped materials remains limited, primarily due to the low electron affinity of n-type materials that strongly restricts the n-doping level. Benzimidazoline-based reductants (Figure1) have recently emerged as efficient and air-stable n-type dopants in electron transporting materials (ETMs) to increase electrical conductivities.[2] Hence we designed and synthesized a series of Benzimidazoline based compounds as air-stable n-dopants and their doping abilities have been surveyed by analysing the electron conductivity trend of organic semiconductors. Moreover an in-depth study of their electrochemical characteristics have been carried out and their molecular orbital energy levels investigated. The most efficient n-doping molecules are intended to largescale, printed electronics for energy-harvesting and storage applications.

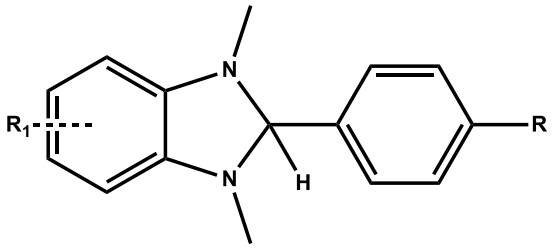

Figure 1: *general structure of benzimidazoline based n-dopants*

[1] B. Lüssem, C.-M. Keum, D. Kasemann, B. Naab, Z. Bao and K. Leo, *Chemical Reviews* **2016**, 116, 13714-13751.
[2] a) Z. Bin, J. Li, L. Wang and L. Duan, *Energy Environ Sci* **2016**, 9, 3424-3428. b) N. B. D., Z. Siyuan, V. Koen, S. Alberto, B. Stephen, M. S. R. and B. Zhenan, *Adv. Mater.* **2014**, 26, 4268-4272.