Organic opto-electronic devices: performance limitations and new device architectures

Organic opto-electronics has seen tremendous progress in the past decades: Organic light emitting diodes are a commercial product which can be found in smart-phones and TV screens, while organic photodiodes reach detectivities comparable to that of silicon in the visible wavelength range.[1] Moreover, organic photovoltaic devices allow for an easy, light-weight integration into buildings and now reach power conversion efficiencies over 20% for lab-scale devices.[2] This presentation will give an overview of the basic photo-physical processes occurring in such organic opto-electronic devices and sensors. Based on our current understanding of charge carrier photo-generation, recombination, and charge transport, we will link molecular and microstructural properties to device performance parameters. This allows us to determine performance limitations for organic photovoltaic and photo-detecting devices.[3,4] I will further discuss novel nano-optical concepts to tune light absorption[5,6] and will review our recent work on new device architectures enabling organic infrared detectors and photon up-conversion.

References:

[1] J. Vanderspikken, K. Vandewal et al. Adv. Funct. Mater. 31, 2104060 (2021), [2] C. Li et al. Nat. Mater. 24, 433 (2025) [3] S. Ullbrich, K. Vandewal et al. Nat. Mater. 18, 459 (2019), [4] S. Gielen, K. Vandewal et al. Adv. Mater. 32, 2003818 (2020), [5] Z. Tang, K. Vandewal et al. Adv. Mater. 29, 1702184 (2017), [6] A. Mischok, K. Vandewal, M. Gather et al. Nat Commun 15, 10529 (2024)

Brief Biography

Prof. Dr. Koen Vandewal obtained his PhD in Physics at Hasselt University in 2009 working on the device physics of organic photovoltaics. After that, he has been working for two years as a Postdoctoral Fellow at Linkoping University in Sweden and another two years at Stanford University in the US. In 2014, he was appointed as endowed professor at the Technische Universitaet (TU) Dresden in Germany. In January 2018, he moved from TU Dresden to Hasselt University leading a research group with the aim to solve fundamental questions in the field of organic, hybrid and molecular electronics with relevance to applications in opto-electronic devices such as organic light emitting diodes, solar cells, energy conversion devices and sensors.