Abstract

This work investigates the multi-level switching capacity of photochromic organic memory diodes (OMEM) with optical and electrical stimuli. These OMEM devices are based on the integration of a cross-linkable dithienylethene **XDTE** as a transduction layer into the layer stack of an organic light-emitting diode. The photochromic **XDTE** molecules can be reversibly switched between two energetically distinct and thermally stable isomers and their difference in HOMO energy is exploited as a switchable hole-injection barrier that controls the electrical current in the device. The ON and OFF states of this device, that are characterized by the fraction of closed **XDTE** molecules in the active layer as $\boldsymbol{X} = 0$ and $\boldsymbol{X} = 0.95$ respectively, exhibit maximum current ON-OFF-ratios in excess of 10^4. Analog multi-level storage within this large dynamic range is feasible by accessing intermediate values of the fraction of closed isomer $0 < \boldsymbol{X} < 0.95$. This is investigated by means of in situ reflection absorption spectroscopy for both optical and electrical switching. The latter is achieved directly via high current-density pulses as well as indirectly with a new device architecture in which an OLED is stacked on top of the OMEM device. This approach enables internal optical switching by an external electrical stimulus. Finally, the integration of individual OMEM elements into an array in a cross-bar geometry is examined, demonstrating that the multi-level storage capacity is retained in such passive matrices for optical and electrical programming.