In recent years, the concept of memristors and resistive random access memory[1] has emerged as a possible alternative to present memory and storage technologies. After a rather short development time, typical memory-related figures of merit (switching speed, data retention, ON/OFF-ratio, integration density, endurance, etc.)[2] are competitive with established technologies, and first commercial products are expected within the following years. Bistable or hysteretic current–voltage (I–V) characteristics have also been observed from a large manifold of organic devices employing different \(\pi\)-conjugated small molecules or polymers as well as dielectric materials like poly(methyl methacrylate) (PMMA).[3-5] The very general behavior was assigned to the formation and rupture of conductive pathways (“filaments”) through the organics and a large degree of material independence can thus be expected.[6, 7] Besides the nowadays well known preferable properties, the use of organic materials also paves the way towards environment friendly “green” fabrication routes. Various innovative printing techniques are capable of contributing to this ambitious goal with benefits like reduced material waste due to additive maskless patterning and low-temperature processing.[8] To date, several
organic devices have been successfully inkjet-printed including field-effect transistors,[9, 10] phodetectors,[11] infrared detectors,[12] light emitting electrochemical cells,[13] light emitting diodes,[14] photovoltaic devices,[15] as well as ferroelectric memories.[16] Furthermore, innovative printing techniques such as electrohydrodynamic printing have been used for the controlled alignment of organic semiconducting nanowires.[17, 18] Still, the printing process is challenging mostly due to the complex interplay between a large number of involved para-meters like ink viscosity, surface tension of substrate and ink, or drying kinetics. From a fabricational point of view a number of additional issues have to be considered like organic layer [LEFT RIGHT ARROW] solvent interaction during printing of multilayer structures and the elevated curing temperatures needed for most nanoparticle based metal inks. From this it is evident that also the processing has a large influence on the device performance. In this work, we report on the fabrication of organic resistive switches (ORS) by inkjet printing and their integration into fully functional crossbar array structures. We show the route towards the first all inkjet-printed ORS as we, step by step, replace the preparation of the functional components (top and bottom electrode and organic layer) from classical fabrication with inkjet-printing. Inexpensive and air stable PMMA was used as organic layer for all devices. For each device configuration a distinct impact to the I–V-characteristics is found and analyzed. The requirements for a rectifying diode as selector element in an array application are predicted by an analytical estimation. Within this context, we present a high-performance pentacene-based 2-terminal organic diode, fulfilling the discussed needs. Finally, a proper cross-talk handling in the resulting 1 Resistor–1 Diode (1R–1D) structure is demonstrated by writing several different patterns into an array.

Stichworte: inkjet-printing; memory arrays; organic electronics; organic memory; resistive switching

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