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Defect healing at room temperature in pentacene thin films and improved transistor performance. WOLFGANG KALB, FABIAN MEIER, KURT MATTENBERGER, BERTRAM BATLOGG, Laboratory for Solid State Physics, ETH Zurich, Switzerland — We observed a healing of defects at room temperature in the prototypical organic semiconductor pentacene. Pentacene thin-film transistors were fabricated and characterized by in situ gated four-terminal measurements. Under high vacuum conditions (base pressure of order 10E-8 mbar), the device performance is found to improve with time. The effective field-effect mobility increases by as much as a factor of two and the contact resistance decreases by more than an order of magnitude. Oxygen/nitrogen exposure and annealing experiments show the improvement of the electronic parameters to be driven by a thermally promoted process and not by chemical doping. The spectral density of trap states was extracted from the transistor characteristics with a powerful scheme which allows for a calculation of the trap densities with high accuracy in a straightforward fashion. We show the performance improvement to be due to a reduction in the density of shallow traps <0.15 eV from the mobility edge, while the energetically deeper traps are essentially unaffected. This peculiar effect is a direct consequence of the weak intermolecular interaction which is characteristic of organic semiconductors.

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