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Low trap density of states in solution-deposited organic semiconductors by Vibration Assisted Crystallization[1] PETER DIEMER, CHRISTOPHER LYLE, YAOCHUAN MEI, Wake Forest University, CHRISTOPHER SUTTON, Georgia Institute of Technology, MARCIA PAYNE, JOHN ANTHONY, University of Kentucky, VEACESLAV COROPCEANU, JEAN-LUC BREDAS, Georgia Institute of Technology, OANA JURCHESCU, Wake Forest University — Solution-deposited organic thin-film transistors suffer from defects at the semiconductor/dielectric interface due to disorder. These defects act as trapping sites and lead to inferior performance compared to single crystals. During the evaporation of a solvent, the solute molecules are driven to minimize their configuration energy: molecules may settle into local energy minimum configurations, characterized by molecular displacements with respect to the global minimum. We demonstrate that applying gentle vibrations of 100Hz or less to the solution during film crystallization perturbs and partially re-dissolves the dislocated molecules, allowing them to escape the local energy minimum and crystallize into the global energy minimum. This results in markedly improved performance in devices based on several solution-cast organic semiconductors due to a decrease in trap density at the organic/dielectric interface. The performance of our Vibration Assisted Crystallization transistors approach that of the corresponding single-crystal devices, as shown in transistors made from 2,8-difluoro-5,11-bis(triethylsilylethynyl) anthradithiophene on SiO_2 dielectric, with mobility of 3 cm^2/Vs, subthreshold slope of 0.43 V/dec, and threshold voltage of 0.7 V. The low interfacial trap density of 6.76x10^{11} cm^{-2} eV^{-1} agrees well with the results of quantum mechanical calculations.

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