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Impact of the air gap in nanowire array transistors[1] JEFFREY MATIVETSKY, Department of Physics, Binghamton University, TONG YANG, Materials Science and Engineering, Binghamton University, JEREMY MEHTA, Department of Physics, Binghamton University — Organic and inorganic semiconducting nanowires are promising for flexible electronic, energy harvesting, and sensing applications. Nanowire arrays processed from solution are particularly attractive for their ease of processing coupled with their potential for high performance. Random stacking has been observed, however, to hinder the collective electrical performance of such nanowire arrays. Here, we employ solution-processed organic semiconducting nanowires as a model system to assess the impact of the air gap that exists under a large portion of the active material in nanowire array transistors. Confocal Raman spectroscopy is used to non-invasively quantify the average air gap thickness which is found to be unexpectedly large - two to three times the nanowire diameter. This substantial air gap acts as an additional dielectric layer that diminishes the buildup of charge carriers, and can affect the measured charge carrier mobility and current on/off ratio by more than one order of magnitude. These results establish the importance of taking the air gap into account when fabricating and analyzing the performance of transistors based on one-dimensional nanostructures, such as organic and inorganic nanowires, or carbon nanotubes.

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