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Molecular Layer-seeded Ultra-thin Top-gate Dielectrics for High Transconductance Graphene Transistors VINOD SANGWAN, DEEP JARIWALA, HUNTER KARMEL, JUSTICE ALABOSON, LINCOLN LAUHON, Department of Materials Science and Engineering, Northwestern University, Evanston, Illinois 60208, TOBIN MARKS, Department of Materials Science and Engineering and Department of Chemistry, Northwestern University, Evanston, Illinois 60208, MARK HERSAM, Department of Materials Science and Engineering, Department of Chemistry and Department of Medicine Northwestern University, Evanston, Illinois 60208 — The potential of graphene in integrated analog and digital circuits can only be fully realized through incorporation of ultra-thin gate dielectrics to enable large-scale small-channel graphene field-effect transistors (GFETs). Atomic-layer deposition (ALD) is a viable technique to fabricate gate-dielectrics, however, it requires a seeding layer on otherwise inert graphene. Here, we demonstrate a single molecule thick perylene-3,4,9,10-tetracarboxylic dianhydride overlayer as an effective seeding layer to grow high-κ Al_2O_3 on mechanically exfoliated graphene for high-performance GFETs. Using an ultra-thin ($<$ 1nm) seeding layer, in contrast to polymer films (5-10 nm), we demonstrate fabrication of the thinnest ALD-grown gate-dielectric (4 nm) reported to date in top-gated GFETs. This yields high performance GFETs with the intrinsic transconductance parameter approaching 2.4 mS and the field-effect mobility $\sim$3000 cm^2/Vs. We also demonstrate generalization of this molecular layer seeded-ALD growth method to higher- κ gate dielectrics, yielding further enhanced GFET transconductance for possible application to radio-frequency circuits.

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