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On-Chip Electrolytic Chemistry for the Tuning of Graphene Devices SCOTT SCHMUCKER, LAURA RUPPALT, JAMES CULBERTSON, US Naval Research Laboratory, JAE WON DO, JOSEPH LYDING, University of Illinois at Urbana-Champaign, JEREMY ROBINSON, CORY CRESS, US Naval Research Laboratory — The inherent interfacial nature of two-dimensional materials has motivated the tuning of these films by choice of substrate or chemical functionalization. Such parameters are generally selected during fabrication, and therefore remain static during device operation. However, the possibility of dynamic chemistry in a tunable solid-state system will enable the development of new devices which fully leverage the rich chemistry of graphenic materials. Here, we fabricate a novel device for localized, dynamic doping and functionalization of graphene that is compatible with CMOS processing. The device is enabled by a top-gated, solid electrochemical cell designed with calcium fluoride (CaF_2) substituting the oxide of a traditional MOSFET. When the CaF_2 is gated, F flows from cathode to anode, segregating Ca and F. In this work, one electrode is graphene. When saturated with fluorine, graphene undergoes covalent modification, becoming a wide-bandgap semiconductor. In contrast, when functionalized with calcium or dilute fluorine, graphene is electron or hole doped, respectively. With transport, Raman, and XPS, we demonstrate this lithographically localized and reversible modulation of graphene's electronic and chemical character.

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