Perfect and imperfect graphene for gas sensing

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For many graphene and 2D material applications (such as electronics), imperfections are systematically hunted down and eliminated, through meticulous materials selection and synthesis, careful assembly of van der Waals heterostructures, and highly optimised cleaning procedures and device processing. Our recent "hot pickup" method allows batch fabrication of clean van der Waals heterostructures with a great flexibility in device architecture, including ultradense patterning with moderate performance penalty. For gas sensing, "defects" and "contamination" may play a beneficial role as active binding sites and functionalisation. Nanopatterning has been demonstrated to significantly improve the detection limit of chemiresistive graphene sensors, and may also provide a key to obtaining selectivity between different gas species. Graphene patterned by block copolymer lithography was used to achieve ppt-level detection limit for NO2 gas. While disorder seems to have a bene ficial effect, the need for reproducibility, selectivity and control in real applications, as well as the need for understanding the sensing mechanisms better, suggests that the ability of making perfect graphene devices, may be still be a key issue for graphene based gas sensing.