System-Level Applications of Two-Dimensional Materials:
Challenges and Opportunities

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Two dimensional materials represent the next frontier in advanced materials for electronic applications. Their extreme thinness (3 or less atoms thick) gives them great mechanical flexibility, optical transparency and an unsurpassed surface-to-volume ratio. At the same time, this family of materials has tremendously diverse and unique properties. For example, graphene is a semimetal with extremely high electron and hole mobilities, hexagonal boron nitride forms an almost ideal insulator, while MoS_2 and other dichalcogenides push the limits on large area semiconductors.

The successful growth of these materials over large areas has allowed their use in numerous system-level demonstrators. For example, the zero bandgap of graphene and its ambipolar conductivity has been used in a wide variety of rf and mixed applications, including frequency multipliers, mixers, oscillators and digital modulators [1]. At the same time, the wide bandgap of MoS_2 and WSe_2 in combination with advanced fabrication technology has enabled its use in memory cells, analog to digital converters and ring oscillators with orders of magnitude better performance than other materials for large area applications [2]. These and other examples [3] will be discussed to highlight the numerous new opportunities of 2D materials.

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References

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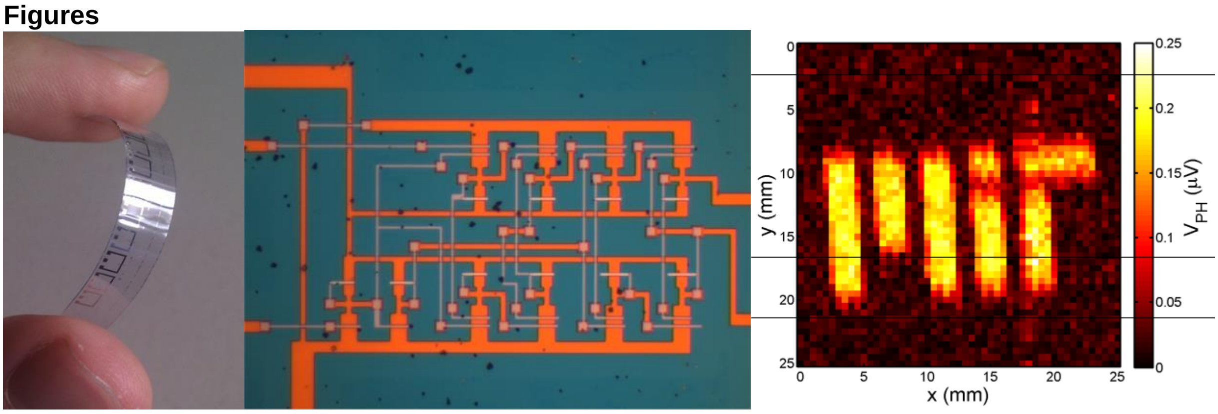
Figures



a) **b)** **c)**

Figure 1. Different examples of system-level applications of two-dimensional materials. a) flexible chemical sensor based on graphene; b) digital circuit fabricated on a MoS_2 layer; and c) mid-infrared image obtained with a graphene imager.