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Leveraging Graphene on Silicon Substrates for Integrated Electronics, Photonics and Electrochemical Applications

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The rediscovery of graphene has undoubtedly opened a unique opportunity for a more aggressive miniaturisation of integrated technologies, thanks to the atomic-thin nature of 2D materials. However, graphene, like every other 2D material, also presents its unique set of challenges. The first challenge revolves around the basic understanding that ideal graphene only exists as a freestanding film in vacuum, and that anything around graphene - made uniquely of surfaces - will affect its final properties within a device. Another challenge is around its capability for integration with silicon technology, requiring a direct, uniform synthesis of the material at the wafer -scale.
We will review the learnings from our epitaxial graphene on silicon carbide on silicon technology. This platform allows to obtain any complex graphene -coated silicon carbide 3D nanostructures in a site – selective fashion at the wafer -scale [1,2]. Key capabilities for nano-optics and MEMS are specifically unlocked by the graphene/silicon carbide combination [3].
For the first time, we have revealed that the sheet resistance of epitaxial graphene on 3C-SiC on silicon is comparable to that of epitaxial graphene on SiC wafers, despite much smaller grains. We also indicate that the control of the graphene interfaces, particularly when integrated, can be a more important factor than achieving large grain sizes [4]. In addition, well- engineered defects in graphene are preferable to defect -free graphene for most electrochemical applications. Examples of application of this technology in the More than Moore domain include integrated energy storage [5], MIR detection [6], and sensors for electro-encephalography [7].

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