

# Grapevine Varieties Identification using a Miniaturized Graphene-based Sensor

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Wine is a highly valued product due to its premium quality and authenticity. However, the adulteration of wines, typically with a mixture of cheaper ingredients and even harmful chemicals and sweeteners, remains a significant issue in the winery industry [1]. Among analytical strategies, the identification of grapevine varieties through DNA analysis paves the way towards a new robust counteraction strategy due to DNA high specificity and stability even under high temperatures, low pH, or chemical treatments during wine processing [2]. In this study, we develop a miniaturized DNA detection platform based on a single-layer graphene field-effect transistor (FET). The graphene chip can be easily operated using a miniaturized output reader directly connected to a laptop. The graphene FET channel, modulated through a liquid-gating setup, is modified with a pyrene-based linker via  $\pi$ - $\pi$  stacking, which preserves the electronic properties of graphene [3]. The integrated system monitors the shifting of Dirac voltage ( $V_{\text{Dirac}}$ ) due to the probe DNA's presence and its hybridization with target DNA. The miniaturized system is applied to identify a series of sequences of nucleotides, representing a set of a fragment from F3H gene of the *V. vinifera* (grapevine), where some varieties show single nucleotide polymorphism (SNP) [4], to identify varieties from Douro (Portugal) protected Designation of Origin (PDO). Our miniaturized platform shows a clear distinction in the hybridization of complementary or mismatched DNA sequences. The signal attenuation corresponding to the higher mismatched nucleobase(s) indicates the good specificity and selectivity of the sensor. Our results show the potential of graphene-FET technology for variety identification and multiplex detection on a chip for a future integration on a micro total analysis system ( $\mu$ TAS) for decentralized analysis.

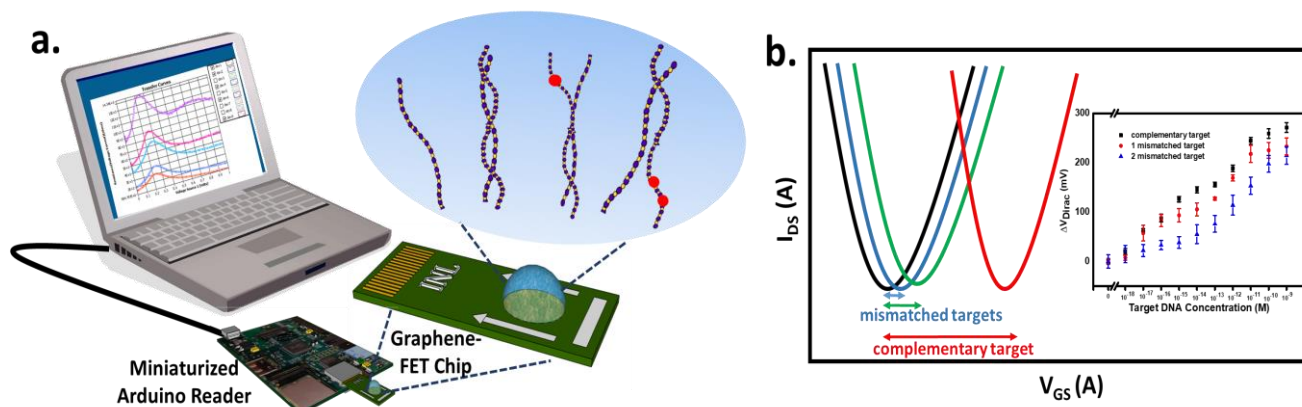
## References

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## Figures



**Figure 1:** a. The miniaturized graphene-FET sensor and b. the transfer curves and calibration plots in DNA-based grapevine varieties identification.