Two-dimensional Materials as Optically Unique Identifiers

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Abstract

As technology has progressed, the trust of everyday interactions has inadvertently been undermined by the sophistication and availability of modern resources. To handle this issue, authentication strategies are implemented to provide proof of identities. Devices providing unique and reproducible fingerprints in response to an applied challenge can supply such identities.

To generate these distinct signatures, physically unclonable functions (PUFs)[1] are commonly utilised. The imperfect manufacturing process used to fabricate these devices provides structures that contain inherent randomness whilst containing a physical attribute that is simple to measure. Due to their physical nature, these structures do not rely on the privacy of stored secrets and can provide hard-to-predict unique identities for authentication in response to a challenge. However, the character of their classical design not only limits their size but also causes vulnerabilities in their security.

In our recent work[2], we show that the fluctuations in the current-voltage spectra of resonant tunnelling diodes (RTDs) containing quantum wells presents a straightforward yet robust measurement that can function as a PUF without conventional resource restrictions, in what we name a QC-PUF.

As an alternative to the reported QC PUF, which relies on circuitry, we have devised a solution that uses an optical measurement, utilising the desired properties of two-dimensional materials. Here, we are interested in the sample-to-sample variations in the photoluminescence from a given 2D material, as demonstrated in Fig.1 (left panel). The practicality of such devices rely on scalability, therefore we have fabricated samples containing thin films of MoS_2 and WS_2 by the Langmuir-Blodgett technique[3], displayed in Fig. 1 (right panel), for the first time. As a result of the non-uniform thickness and coverage, these thin films show large-area photoluminescence where the wavelength, intensity and linewidth depends highly on position. Importantly, these devices are impossible to clone even with state-of-the-art technology, thus providing a novel authentication strategy based on two-dimensional nanomaterials.

References

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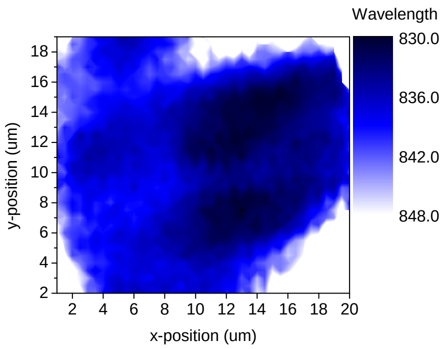
Figures



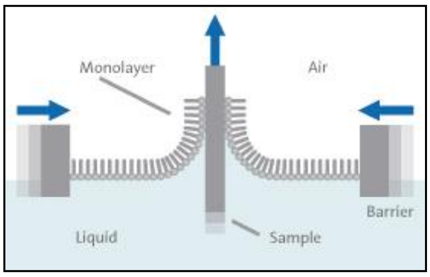


Figure 1: A typical photoluminescence map from a 2D flake (left) and the operation principle of Langmuir-Blodgett deposition (right).