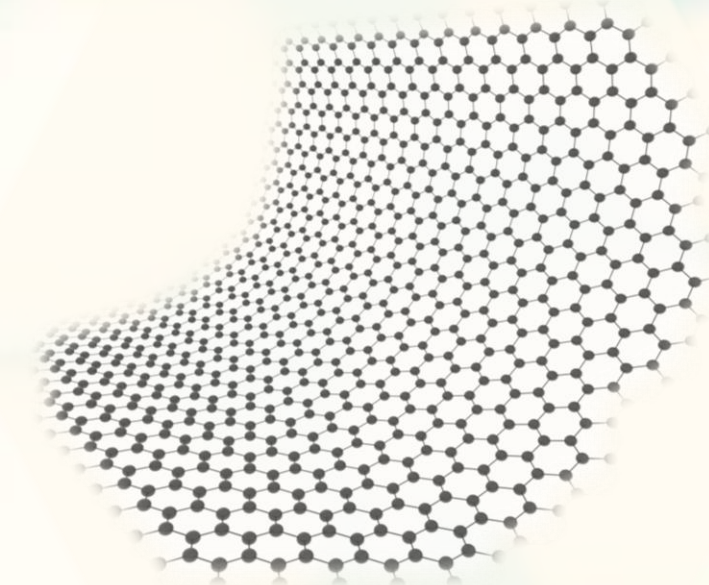


Graphene is experimentally isolated for the first time



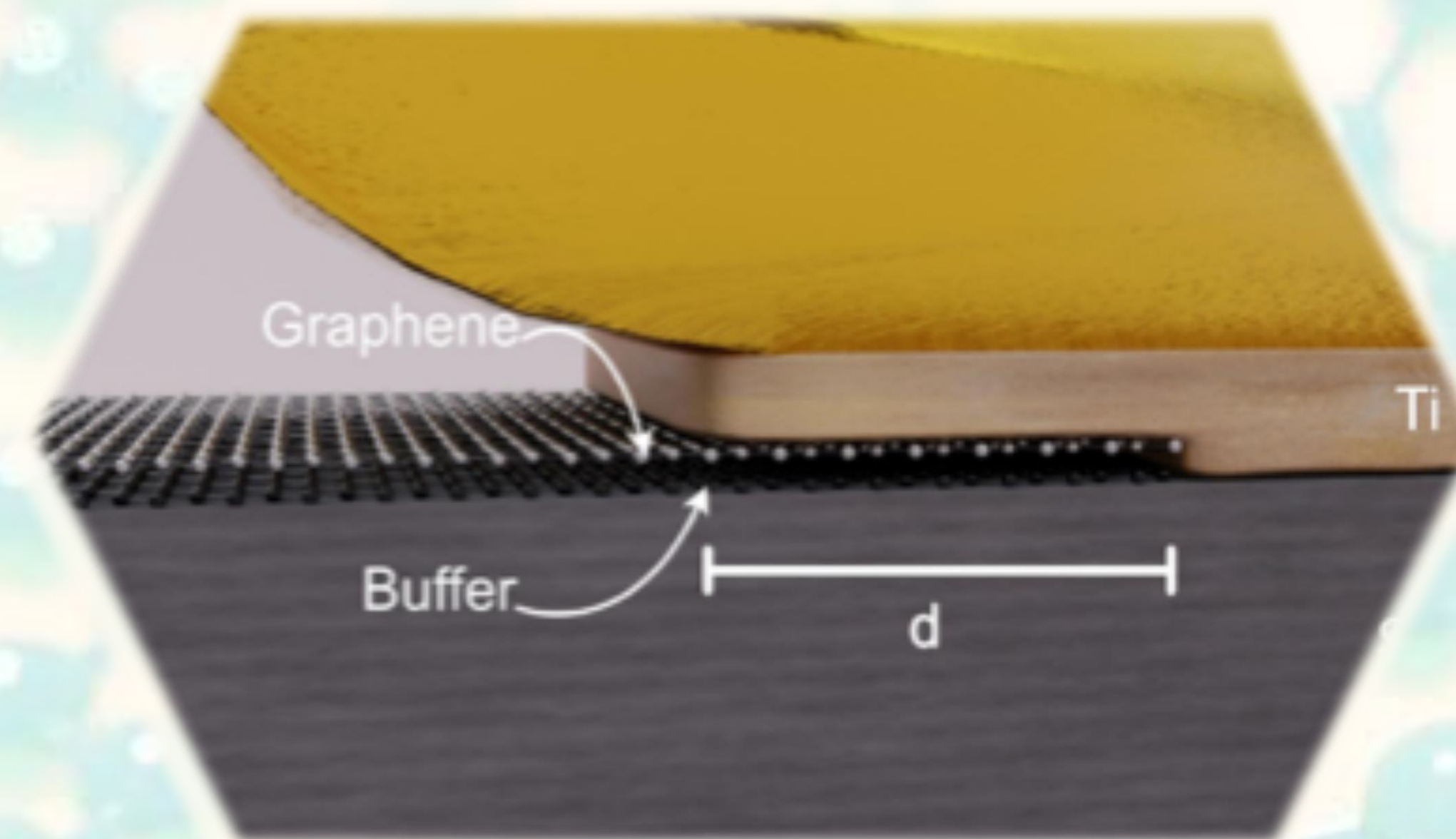
2004 [1]

Graphene enables operation under relaxed conditions – enabling “portable” quantum standards. Due to its ease-of-use, graphene is poised to replace conventional materials.



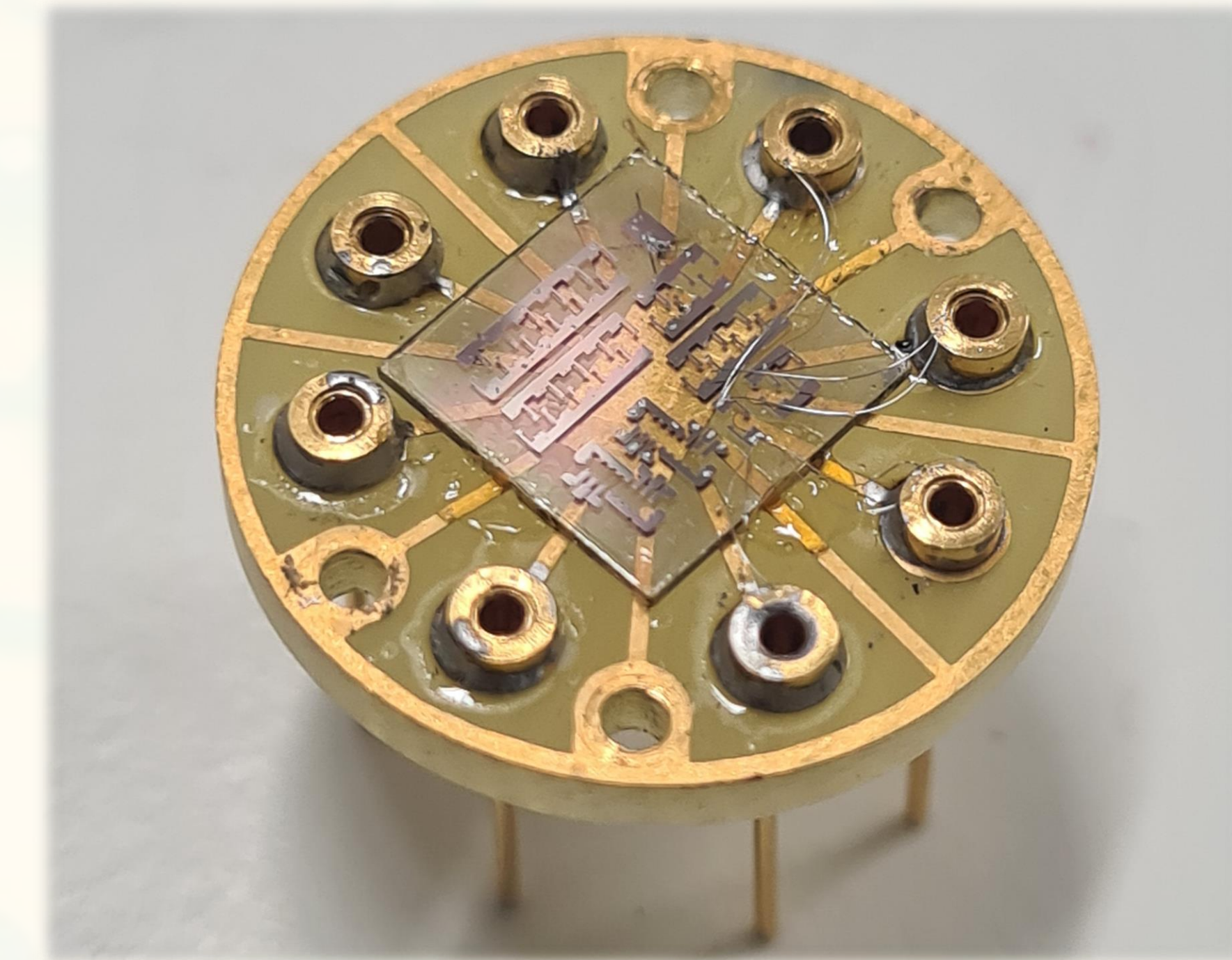
2015 [3-4]

Development of edge-contacts, especially in combination with superconducting leads, enables reproducible fabrication of devices with low contact resistances, important for accurate resistance calibrations.



2019 [6-7]

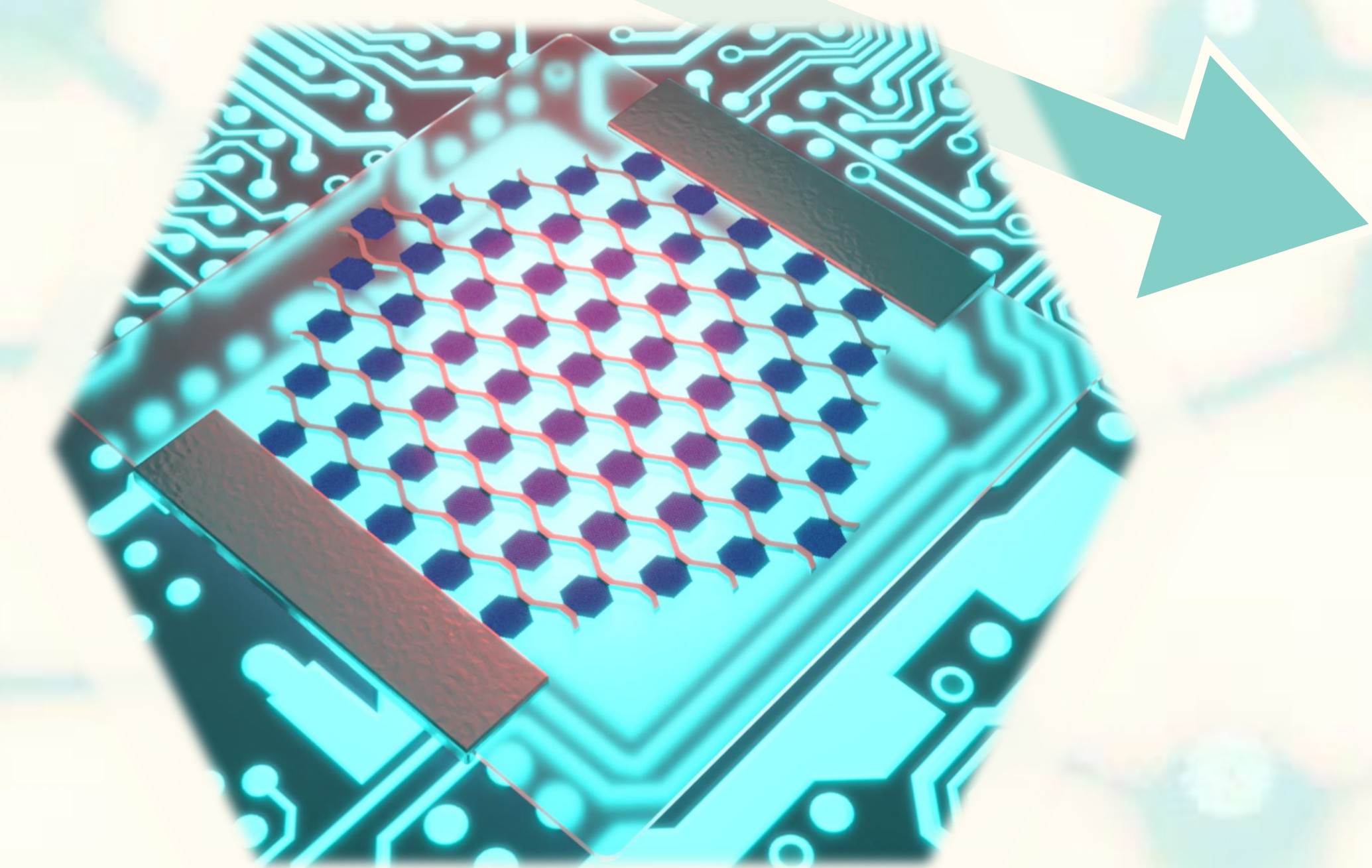
Today, Graphene Quantum Hall Arrays are seeing more wide-spread use. The technology has matured to the point where RISE offers commercially available devices. The use of graphene in metrology is perhaps the only case where the unique 2D-nature of graphene is fully utilized to outperform conventional materials.



Beside simply improving resistance calibrations, arrays have also found use for generation of quantized currents (EURAMET-AQuantEC) and improving the Kibble balance [10]. Work is also underway to establish international standards for the use of graphene and arrays in metrology (CEEM-TG-Graphene).

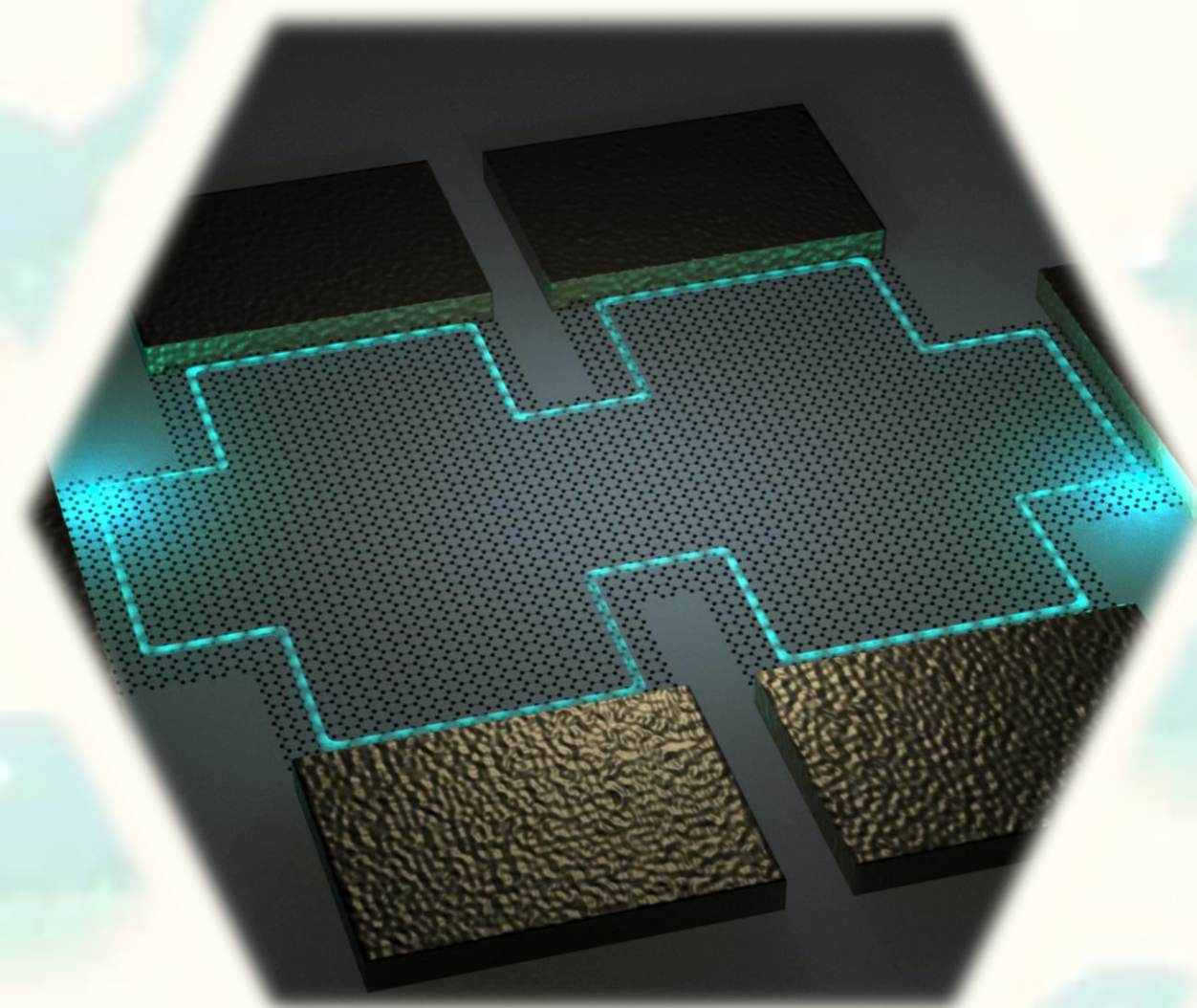
2025 [11]

What does the future hold?



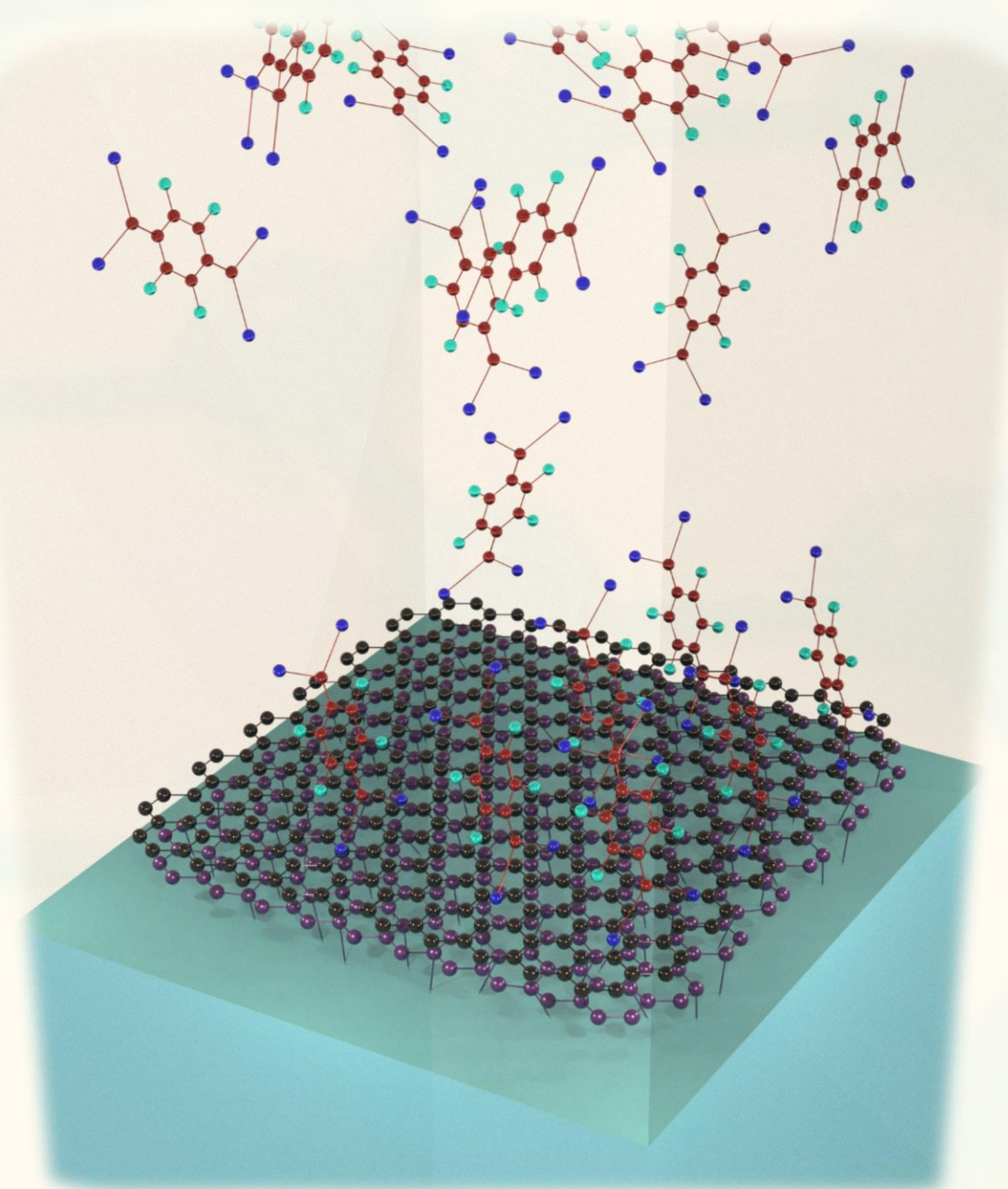
The combination of several technological advances led to the creation of next-generation graphene devices in the form of Graphene Quantum Hall Array Resistance Standards (QHARS) using superconducting leads. Arrays greatly increase application areas since they can have a wide range of quantized resistance values.

2010 [2]



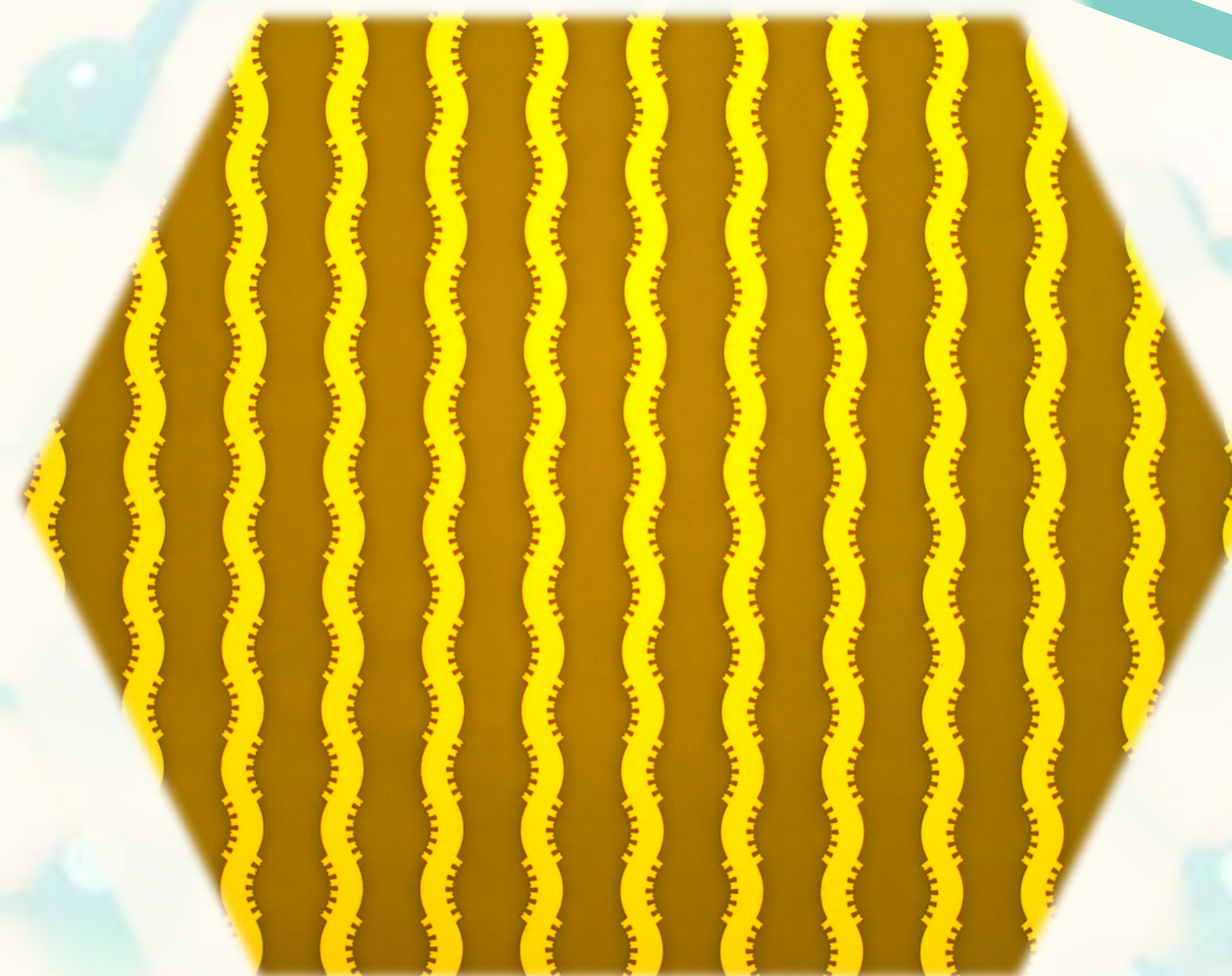
Epitaxial graphene on silicon carbide proves itself viable for use in quantum metrology – via the quantum Hall effect – as a primary resistance standard.

2018 [5]



Reliability of graphene-technology continues to improve. Scalable methods such as molecular doping are used to fine-tune electrical properties, which is crucial for optimization of device performance.

2022 [8-9]



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