Spring 2026 Colloquium
Materials Department

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Physics Department

University of Warwick

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11:00 am | ESB 1001

When Holes Outrun Electrons: Redefining the Limits of Semiconductor Transport on Silicon

For over half a century, the trajectory of semiconductor physics has been guided by a simple assumption: electrons are fast, holes are slow. This hierarchy has shaped materials design, device architectures, and even the conceptual foundations of modern electronics and quantum technologies. But what if this assumption is no longer true?

In this colloquium, I will present the emergence of a new quantum material platform, compressively strained germanium on silicon (cs-GoS), in which this long-standing paradigm is overturned. By engineering the valence band at the atomic scale and eliminating disorder with unprecedented precision, we realise a two-dimensional hole system exhibiting mobilities exceeding $7\times10^{6}cm^{2}V^{-1}s^{-1}$, the highest ever achieved on silicon, and a regime where holes decisively outperform electrons. In this regime, holes decisively outperform electrons, a phenomenon not observed in any other semiconductor platform to date.

This result is not simply an incremental advance; it signals a qualitative shift in how we think about charge transport in semiconductors. I will show how strain, confinement, and heterointerface perfection can be combined to fundamentally reshape the valence band, suppress scattering, and unlock a transport regime previously thought inaccessible in a silicon-compatible system.

Beyond transport, this platform naturally unifies properties that have traditionally been mutually exclusive: ultra-high mobility, strong spin–orbit coupling, low hyperfine interaction, and full compatibility with industrial silicon technology. In doing so, it challenges the conventional separation between “exotic” quantum materials and scalable semiconductor platforms.

The implications are far-reaching. From rethinking the role of holes in low-power and cryogenic electronics, to enabling electrically controlled spin qubits and long-range quantum coupling architectures, cs-GoS opens a pathway towards quantum functionality without abandoning silicon.

This is not just a better material; it is a redefinition of what is possible within the silicon paradigm.

Bio

Maksym Myronov is an Associate Professor (Reader) in Physics and Head of the Semiconductors Research Group at the University of Warwick. He is an internationally recognised scientist, researcher, and inventor specialising in epitaxial growth, advanced materials characterisation, and semiconductor device technologies across the full group-IV materials platform, including silicon, germanium, silicon-germanium,

germanium-tin, silicon-boron, silicon-carbon and various polytypes of silicon carbide, as well as selected III–V systems.

He is widely known for pioneering the compressively strained germanium on silicon (cs-GoS) platform, establishing new routes to engineer ultra-high-mobility low-dimensional systems and enabling breakthroughs in quantum materials and devices. His work has opened a new regime in which hole transport can surpass conventional limits, positioning group-IV semiconductors as a leading platform for next-generation electronics and quantum technologies.

His research spans the intersection of physics, materials science, and engineering, with applications in electronics, photonics, thermoelectrics, spintronics, photovoltaics, sensing, and quantum technologies.

Professor Myronov has authored approximately 200 peer-reviewed publications and four book chapters, delivered over 200 invited and contributed talks at international conferences, and filed more than ten patents. In the past two years alone, he has filed five patents focused on multi-qubit control, novel device concepts, and advanced sensing technologies based on the cs-GoS platform.

He maintains extensive international collaborations across academia and industry, working with leading partners in the UK, Europe, North America, and Asia, and plays an active role in advancing semiconductor and quantum technologies at the global level.

https://warwick.ac.uk/MaksymMyronov

Hosted by Greg Mazur.