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How one can increase sustainability in a semiconductor lab?

Interview with Claire Blaga, EPFL

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The Intersection of Physics and Purpose

***Claire Blaga**, EPFL, is a PhD candidate whose journey into science was driven by a fascination with fundamental principles. After completing MSc, she sought a field that offered both intellectual challenge and tangible impact – ultimately finding a home in semiconductor physics. Her story, however, extends beyond scientific inquiry to include a growing awareness of sustainability, both in research and daily practice.*

From Fundamental Physics to Sustainable Innovation

What drew you to physics, and when did sustainability become part of your scientific identity?

Claire: I've always been captivated by the fundamental principles that govern our universe. Physics, showing a unique power to explain the world, challenges me in a way that feels uniquely rewarding. My path took a decisive turn during my master's thesis in industry, where I realized that a critical mind wasn't always welcomed. I wanted to work in a field where I could ask hard questions and see real-world applications. Semiconductor physics spoke to me – it's hands-on, theoretical, and ripe for innovation. Around the same time, I became more aware of sustainability, from watching documentaries on the fishing industry's impact on tuna populations to participating in local initiatives like urban beekeeping and community vegetable gardens. These experiences made me think deeply about energy, technology, and our responsibility as scientists.

How did you choose the topic of your doctoral thesis?

My experience in industry clarified what I did not want: a setting where critical analysis was discouraged. Solid-state physics, particularly semiconductor physics, offered the intellectual rigor and practical relevance I sought. Joining a lab with robust facilities and a supportive atmosphere allowed me to explore materials like transition metal dichalcogenides (TMDs), which hold promise for low-power, high-density transistors beyond silicon's limits as well as quantum communication. The autonomy to innovate – coupled with my supervisor's guidance – enabled me to question not only the science but also its sustainability.

These experiences now guide my research goals: to develop TMD-based device architectures that unite high performance with scalable, environmentally conscious design. Specifically, I aim to integrate TMD monolayers with III–V semiconductor nanostructures, leveraging their complementary properties to achieve precise control over electronic and optical behavior. By investigating how strain and interfacial effects influence excitonic and single-photon emission, I seek to establish reproducible methods for tuning these phenomena at the nanoscale. This approach not only advances the scalable and deterministic engineering of single-photon emitters but also contributes to the broader effort to create sustainable, next-generation quantum and optoelectronic technologies [1].

Sustainability in the Lab: Challenges and Progress

Your research focuses on sustainable semiconductor materials. How is sustainability integrated into your lab's daily operations?

Sustainability initiatives in our lab began as a grassroots effort. In 2022, a PhD colleague introduced the LEAF framework [2], and we achieved bronze certification – a starting point for basic practices like reducing energy consumption. However, we quickly realized that improving the lab operations' sustainability required more than just turning off lights or PCs when not in use. This year, I decided to initiate efforts to go further by integrating deeper actions into our operations.

Our focus now extends to optimizing equipment use, streamlining purchasing processes, improving waste management, and refining data management protocols, amongst others. Experimental labs are inherently resource-intensive, with equipment like turbo pumps and lasers as well as consumables such as semiconductor wafers, both generating significant environmental impact. The challenge is to embed sustainability into every aspect of our work, from daily operations to long-term research planning. This means not only raising awareness but actively seeking innovative solutions to reduce our environmental footprint while maintaining scientific excellence.

How do you navigate the challenge of integrating sustainability into a field where excellence and precision are non-negotiable?

Excellence in research requires a clear vision, meticulous preparation, and a deep understanding of the subject. Sustainability, in this context, is not an add-on but a framework that enhances scientific rigor. By evaluating the environmental impact of our work, we gain a more comprehensive understanding of the systems we study and the resources we employ. This perspective drives us to optimize experiments for both precision and efficiency, developing protocols that are both effective and responsible.

Every experiment presents an opportunity to ask: Can we achieve equivalent – or superior – results through more sustainable, efficient, or innovative methods? This approach does not compromise quality; it refines it. It involves questioning established methods, exploring alternatives, and accepting the additional effort required to align cutting-edge research with responsible practices. The outcome is re-

search that is not only groundbreaking but also mindful of its broader implications.

Challenges in Combining Research and Sustainability

What are the biggest challenges in combining cutting-edge research with sustainability?

The primary challenge is the structure of the research environment itself. Many labs struggle to adopt sustainable practices due to cultural barriers or a lack of support for experimenting with new methods. Funding systems often prioritize immediate results over long-term process improvements, making it difficult to justify investments in sustainability.

In contrast, our lab benefits from an open and collaborative atmosphere. Our PI and colleagues are committed to exploring how we can maintain scientific excellence while minimizing our environmental footprint. For example, we organized a brainstorming workshop where all members – regardless of seniority – contributed ideas for actionable sustainability measures. This collaborative approach is critical. It's not solely about resources; it's about fostering a culture where questions like How can we improve? are actively encouraged and addressed, and where each member of the lab feels involved and responsible.

A Call for Systemic Change

If you could propose one systemic change to support sustainability in research, what would it be?

That's a challenging question to me as a PhD… I think scientists must take greater responsibility for the broader impact of their work. Mandatory courses on the environmental implications of research could help raise awareness among students. While top-down policies are necessary, building a community – particularly among early-career researchers – is equally important. Conferences and networks play a vital role in this, bringing together diverse perspectives to generate innovative solutions.

Personally, I once believed that controlling every detail myself was the only way to ensure quality. However, my experience in research and sustainability has demonstrated the value of delegation and collaboration. Two brains are indeed better than one! Embracing others' ideas and approaches has led to outcomes that are not only more efficient but also more innovative and effective than what I could achieve alone. This shift in mindset has been transformative, both for my research and for our lab's approach to sustainability.

Looking Ahead: The Future of Sustainable Research

Claire's work exemplifies the intersection of scientific curiosity and ethical responsibility. By integrating sustainability into both research and lab culture, they contribute to redefining the role of scientists in addressing global challenges.

References

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