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Nanoscale Horizons Emerging Investigator Series: Dr Mindaugas Juodėnas, Kaunas University of Technology, Lithuania

Our Emerging Investigator Series features exceptional work by early-career nanoscience and nanotechnology researchers. Read Mindaugas Juodėnas's Emerging Investigator Series article 'Lasing in an assembled array of silver nanocubes' (https://doi.org/10.1039/D4NH00263F) and read more about him in the interview below.

Dr Mindaugas Juodėnas is a senior researcher specializing in nanophotonics and optical metasurfaces at the Institute of Materials Science, Kaunas University of Technology (Lithuania). He earned his PhD in Materials Engineering from the same university in 2021, with research focused on capillary-assisted nanoparticle assembly and its potential for fabricating optically active structures. During his PhD studies, he participated in the European doctoral network PCAM and was awarded a European Doctorate Certificate as a supplement to his diploma. His thesis was recognized among the best by the Gian Paolo Brivio International Award. From 2021 to 2023, he was a postdoctoral researcher at the Department of Physics, Chalmers University of Technology (Sweden), where he explored monolithic metasurfaces for seamless integration with optoelectronic devices. His current research centers on the design and fabrication of plasmonic and photonic nanostructures, with particular interest in self-assembled metasurfaces, nanoscale light–matter interactions, and metaoptics for ultrafast laser applications.

Read Mindaugas Juodėnas's Emerging Investigator Series article 'Lasing in an assembled array of silver nanocubes' (https://doi.org/10.1039/D4NH00263F) and read more about him in the interview below:

NH: Your recent Nanoscale Horizons Communication describes a surface lattice resonance (SLR)-based plasmonic nanolaser that leverages bulk production of colloidal nanoparticles and assembly on templates with single particle resolution. How has your research evolved from your first article to this most recent article and where do you see your research going in future?

MJ: My research journey began with exploring capillary-assisted nanoparticle assembly during my graduate studies. This led to the successful assembly of colloidal nanoparticles—particularly monodisperse Ag cuboctahedra synthesized by our collaborators at the National Institute for Materials Science in Japan—into regular lattices. At first, we did not realize these self-assembled systems could support surface lattice resonances (SLRs), but routine optical transmittance measurements revealed them. This unexpected finding, made possible by the exceptional quality of the nanoparticles, sparked a deeper investigation into SLR physics and its potential applications. Our goal then became clear: to demonstrate a plasmonic nanolaser using bulk-produced colloids and scalable, template-assisted assembly. It took time—and extended beyond my PhD—but reaching that milestone brought a sense of closure to that chapter. Looking ahead, we aim to further develop these light-emitting systems by improving their efficiency, robustness, and overall performance. Ultimately, we hope to bring these devices out of the lab and into real-world applications.

NH: How do you feel about Nanoscale Horizons as a place to publish research on this topic?

MJ: *Nanoscale Horizons* is an inspiring venue where innovation in nanoscience truly takes center stage. I particularly appreciate the journal's emphasis on conceptual novelty over incremental progress. The "new concepts" requirement encouraged us to distill our work into its most impactful elements, with greater clarity and a more forward-looking perspective than a

typical abstract. I also value the broader Nanoscale journal family—*Nanoscale Advances*, *Nanoscale*, and *Nanoscale Horizons*—as a thoughtful framework for aligning manuscripts with their originality and impact.

NH: What aspect of your work are you most excited about at the moment?

MJ: I am currently transitioning to independent research, which brings the creative freedom to pursue new ideas and mentor aspiring researchers. I am particularly excited to carve out my own direction in optical metasurfaces—a field rich with untapped potential. I believe we can use these systems not only to demonstrate fascinating optical phenomena, but also to push metaoptics toward functional, real-world devices. This shift has already begun, with integrated components starting to appear, but I see immense opportunity for these novel devices to impact a much broader range of everyday technologies.

NH: In your opinion, what are the most important questions to be asked/answered in this field of research?

MJ: Focusing specifically on plasmonic nanolasers based on SLRs, I believe the field must address several pressing questions in order to turn this exciting physics into viable technologies: (i) How can we further reduce the losses inherent in plasmonic devices without compromising their unique advantages? (ii) What novel energy input strategies, beyond optical pumping, can make these devices more practical and energy-efficient? (iii) How can we transition from lab-scale demonstrations to robust, scalable systems suited for real-world applications?

NH: What do you find most challenging about your research?

MJ: One of the biggest challenges is navigating the unpredictability and complexity of nanoscale systems. Experiments often diverge from theoretical predictions in more complex systems, and uncovering the underlying reasons can require extensive iteration and analysis. These technical challenges are compounded during the transition to independent research, which comes at the cost of time for hands-on experimentation—something I deeply enjoy. The focus shifts toward building a team, mentoring students, and managing projects, alongside the steep learning curve of securing funding. Still, it is this blend of intellectual rigor, creative exploration, and strategic problem-solving that makes the journey so rewarding.

NH: In which upcoming conferences or events may our readers meet you?

MJ: Our team's work frequently appears in EMRS meetings and will also be presented at META 2025 – the 15th International Conference on Metamaterials, Photonic Crystals and Plasmonics – in July, though I will not be able to attend in person this year. However, I plan to attend SPIE Photonics West and META 2026 next year. I would be thrilled to meet readers and discuss each other's work there!

NH: How do you spend your spare time?

MJ: I wish I had more of it! I do my best to keep some long-standing hobbies alive. One of my favorites—ballroom dancing—is both a great way to recharge and a surprising source of clarity; I have often found new insights into research problems right after a practice session. I also try to stay in touch with the world of video games, though these days I am more of a collector than an active player. Other than that, nothing beats just spending time with my wife and our dog, Mando!

NH: Can you share one piece of career-related advice or wisdom with other early career scientists?

MJ: Always assume that whatever you do will most likely fail—and that's totally okay. For me, research often feels like starting on a well-trodden path, then gradually veering into overgrown trails, eventually wandering through a dense forest filled with dead ends, fallen trees, and the remnants of ideas left by previous generations of researchers. But it only takes one success to illuminate a new path no one has seen before. Embrace failure not as a setback but as an essential part of the process. Every failed attempt teaches you something valuable—what not to do, what to try next, what questions still matter. Research rewards those who are willing to explore the unknown and keep going, even when the path disappears beneath their feet.