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Nanoscale Horizons Emerging Investigator Series: Dr Jovana Milić, University of Fribourg, Switzerland

Our Emerging Investigator Series features exceptional work by early-career nanoscience and nanotechnology researchers. Read Jovana Milić's Emerging Investigator Series article 'Resistive switching memories with enhanced durability enabled by mixed-dimensional perfluoroarene perovskite heterostructures' (https://doi.org/10.1039/D4NH00104D) and read more about her in the interview below.

Dr Jovana Milić has been an Associate Professor at the University of Turku in Finland since September 2024 (as an ERC Starting Grantee and the Research Council of Finland Fellow) and Group Leader at the Adolphe Merke Institute of the University of Fribourg in Switzerland (Swiss National Science Foundation PRIMA Fellow) since September 2020. Her research is centered around the development of smart and sustainable materials for renewable energy technologies, with a particular focus on photovoltaics. This has involved supramolecular strategies in stimuli-responsive framework materials through a multidisciplinary approach at the interface of chemistry, physics, material science, and engineering. She has been recognized by a number of honors and awards, such as the Journal of Materials Chemistry Lectureship 2024, Zeno Karl Schindler Prize 2021, Green Talent Award 2020, and CAS Future Leader 2019. In addition to research and international collaborations, she is invested in science for policy and diplomacy as a member of Swiss, European, and Global Young Academies, as well as the International Science Council Fellow, dedicated to connecting and supporting scientists globally.

Read Jovana Milić's Emerging Investigator Series article 'Resistive switching memories with enhanced durability enabled by mixed-dimensional perfluoroarene perovskite heterostructures' (https://doi.org/10.1039/D4NH00104D) and read more about her in the interview below:

NH: Your recent Nanoscale Horizons Communication reports the construction of solar cell memory devices by applying hydrophobic perfluoroarene cations on the surface of mixed halide perovskite thin films. How has your research evolved from your first article to this most recent article and where do you see your research going in future?

JM: Thank you for recognizing this work, which aimed at demonstrating solar cell memory devices by relying on mixed-dimensional halide perovskite materials. This work has evolved from our early research on using supramolecular strategies to develop low-dimensional perovskite materials and enhance their stability in photovoltaics, such as by π-based interactions in perfluoroarene systems. We have also relied on these approaches to control mixed conductivities of hybrid perovskite materials and their operational stability, which is relevant to the development of innovative memory elements for neuromorphic computing. Finally, this provided the background for us to team up with our collaborators at HMU and the group of Prof. Emmanuel Kymakis and Dr Konstantinos Rogdakis, with extensive expertise in perovskite optoelectronics and memory elements, enabling us to jointly demonstrate solar cell memory devices, incorporating such mixed dimensional perovskites. This offers a promising platform for developing more energy-efficient memory elements for neuromorphic computing, which can also be self-powered in the future.

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

JM: *Nanoscale Horizons* has emerged as a unique venue for research developments that demonstrate new concepts and challenge conventional research in nanomaterials and devices. This was an ideal platform for our research as it highlights a conceptual breakthrough in mixed dimensional perovskite solar cells and resistive switching memories by advancing their function to ''solar cell memories''. I believe that our research community recognizes the relevance of the journal in highlighting such new concepts, and I appreciate the opportunity to contribute.

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

JM: I am fascinated by bioinspired materials and brain-inspired memory devices, as well as the role of hybrid framework materials in this context. With that mindset, I am very excited about the prospect of using hybrid mixed-dimensional perovskites to develop other self-powered memories for neuromorphic computing, and I am eager to contribute to advancing this research field.

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

JM: Some of the most critical questions in this field of research are related to the underlying mechanisms that enable resistive switching or 'memristive' behavior of hybrid halide perovskite materials. I believe this requires cross-disciplinary collaborations, such as the one we could nurture with our colleagues at HMU and others worldwide, to tackle the challenges of understanding the mechanisms and advancing these systems beyond conventional technologies.

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

JM: One of the main challenges of this research is the operational instability of hybrid halide perovskites, which benefits from using mixed-dimensional perovskites that are more operationally stable. In addition, the critical challenge that complements the instability is the environmental impact of lead-based perovskite materials, which need to be replaced by more sustainable alternatives. Finally, there is a need for a multi-dimensional methodological assessment of these materials during operation. This is probably the most challenging aspect since a simultaneous evaluation of structural and optoelectronic properties in devices remains elusive, and we need to advance our methods to address this critical challenge in the future.

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

JM: I will be attending several international meetings and conferences next year, such as the International Hybrid and Organic Photovoltaics Conference (HOPV25) in Rome (Italy) and the Materials Research Society (MRS) Conference in Singapore, as well as the ERC Conference on the subject ''From Responsive Molecules to Interactive Materials'' in Tampere (Finland), among others. I look forward to meeting the community on these occasions!

NH: How do you spend your spare time?

JM: I spend my spare time invested in connecting, supporting, and empowering scientists at the interface of science for policy and science diplomacy as a member of the Swiss, European, and Global Young Academies, as well as being an International Science Council Fellow. I believe these engagements are critical to addressing some of the most pressing issues of our time, such as the climate emergency, which requires strengthening the trust in science and sustainable development for a broader societal impact. Otherwise, I enjoy spending most of my time with my family, especially our 3-year-old daughter, who continuously challenges my perspective and motivates me to do more to make this world a better place for future generations.

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

JM: If I am to share one piece of career-related advice or wisdom with other early-career scientists, it is to encourage them to pursue their passion and vision of success by embracing their authenticity, unique backgrounds, and journeys without allowing the imaginary expectations imposed by our (academic) environment to prevent them from realizing their own path. I hope this can also serve as a reminder to our fellow scientists of why science is worth pursuing...