Invited talk. 30/10/2024 in Tübingen.

Title: Advanced solar cells based on nanomaterials

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Bio: Elisa Antolin is an associate professor at Instituto de Energía Solar, a research centre within the Universidad Politécnica de Madrid. Her research focuses on new photovoltaic materials and devices architectures, including ultrathin solar cells made of two-dimensional materials, three-terminal multijunctions and quantum dot devices.

Abstract: The current energy transition demands a new generation of solar cells with low cost, and most importantly, low environmental impact. Furthermore, to make solar energy ubiquitous, these solar cells must adapt to new applications, such as building and vehicle integration, indoor and wearable energy harvesting, or rollable solutions. This requires devices to be highly efficient, flexible, ultrathin, ultralightweight, and possibly semitransparent. This talk focuses on the opportunities that nanomaterials, such as 2D materials and quantum dots, offer for the development of ultrathin high-efficiency solar photovoltaic devices.

I will begin by briefly reviewing the fundamentals of photovoltaic energy conversion. Then I will introduce transition metal dichalcogenides such as MoS_2 and WSe_2 as excellent semiconductors for making ultrathin solar cells due to their layered crystalline structures and extremely high light absorption coefficients. I will review the technological challenges associated with the fabrication of solar cells based on quasi-2D-crystals of MoS_2 (crystals with thicknesses between $\sim$ 5 and 100 nm). I will demonstrate that large open-circuit voltages ($\sim$1 V) can be achieved in MoS_2 homojunction ultrathin devices under concentrated light and discuss the impact of surface effects, contact technology, and optical design. I will also describe the potential use of this emerging technology for fabricating semitransparent, power-generating windows. Finally, I will explain how quantum dot-based devices can achieve higher energy conversion efficiencies than conventional solar cells.