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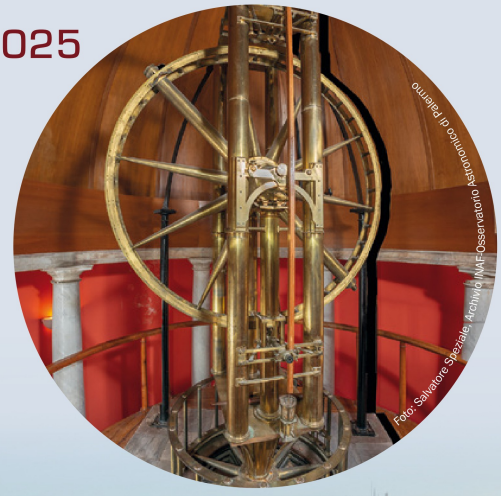

Università degli Studi di Palermo

INTERNATIONAL YEAR OF Quantum Science and Technology

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in presenza di particolari elettroliti. La combinazione di questi sistemi con dicalcogenuri di metalli di transizione bidimensionali può ampliare il campo di applicazione. In questo lavoro, viene prima presentata una nuova strategia per la produzione di MoS_2 a bassa dimensionalità mediante tecnica di esfoliazione in fase liquida assistita da microonde e successivamente i risultati ottenuti nell'utilizzo di tali dicalcogenuri come parte di eterogiunzioni con membrane in elettroliti liquidi mediante studi di voltammetria ciclica, spettroscopia di impedenza elettrica e analisi del potenziale transmembrana.

Driving ions in reverse: spectroscopic insights into bias-induced migration in perovskite solar cells.

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Within the renewable energy technologies, solar cells have been subjected steadily to a growing market demand. Such demand drives efforts to improve the energy conversion efficiencies at accessible costs. Lead Halide Perovskites are among the most promising materials to meet this goal due to their strong light absorption, tunable bandgaps and low cost. However, key challenges remain in material degradation and long-term device performance. Our research aims to investigate ion-vacancy migration processes on FAPbBr3, generated by a reverse bias in solar cells. The latter will be carried out by Raman spectroscopy, so to evaluate structural differences due to the ionic movements. In addition, steady-state and time-resolved photoluminescence will be employed to explore the electronic dynamics during these structural transitions. This contribution has been developed in the framework of the project Network 4 Energy Sustainable Transition - NEST, code PE0000021, CUP B73C22001280006, Spoke 1, funded under the National Recovery and Resilience Plan (NRRP), Mission 4, by the European Union - NextGenerationEU.

Thermal modulation of optical and electronic features of 2D Molybdenum Disulfide on SiO_2/Si.

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Two-dimensional materials like molybdenum disulfide (MoS_2) are promising for future electronic and optoelectronic devices. Single-layer MoS_2 ($1L - MoS_2$), with its 1.8 eV bandgap and strong fluorescence, is a key candidate, but achieving uniform large-scale synthesis remains difficult. Properties such as strain and doping are strongly influenced by both the growth method and the substrate. This study compares $1L - MoS_2$ grown by chemical vapor deposition on SiO_2/Si with samples from gold-assisted exfoliation, applying thermal treatments in O_2 and Ar to tune physical properties. Raman and photoluminescence analyses show that Ar mainly reduces strain, while O_2 also decreases n-type doping and enhances

fluorescence up to sevenfold. No significant morphological damage occurs below 225°C. These results suggest a reproducible post-synthesis strategy to optimize MoS for device applications, regardless of the growth method.

Giant Berry-phase-driven X-ray beam translations in strain-engineered semiconductor crystals.

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The manipulation of light through its interactions with artificially structured media is a key tenet of photonics. Extending this concept to the X-ray realm-thus enabling control of X-ray light with the precision seen in the visible/IR range-has been hindered by the challenge of realizing photonic structures with the required sub-nm resolution. A promising approach to this challenge leverages the Berry-phase effect, where X-ray beams undergo large translations in a deformed crystal due to the presence of Berry curvatures in both real and reciprocal space. Here, the controlled crystal distortions required to rein in this effect are obtained by pairing the lattice expansion observed upon H irradiation of GaAsN with spatially selective hydrogenation. The observed ¿100 μm beam translations are a macroscopic manifestation of the Berry curvatures associated with the sub-nm, H-induced distortions introduced in the lattice. The comparison with a dedicated theoretical model traces the individual translation branches observed in X-ray transmission back to specific deformation features, establishing a predictive framework for the control of X-ray propagation in the fabricated structures.