



AVVISO DI SEMINARIO

Il giorno 9 Aprile alle ore 14.00
nell'aula Seminari

La Prof.ssa Marina Freitag

terrà un seminario dal titolo

“Diffuse Light to Structured Information”

Proponente: Prof.ssa Marilena Carbone

Diffuse Light to Structured Information

Marina Freitag

Molecular engineering of dye-sensitized solar cells (DSCs) has catalyzed a paradigm shift in indoor photovoltaics (IPV), enabling the realization of self-powered, intelligent Internet of Things (IoT) devices. Through synergistic co-sensitization of XY1 and L1 dyes, power conversion efficiency has surged from 29.0% to 38.0% under 1000 lux fluorescent illumination [1,2]. Precise tailoring of the Cu(II/I)(tmby)₂ electrolyte, with Cu(II) concentration optimized to 0.06 M, has yielded an exceptional open-circuit voltage of 0.995 V and short-circuit current density of 147 $\mu\text{A cm}^{-2}$ [2].

Interfacial dynamics, probed via photoinduced absorption spectroscopy, have revealed efficient dye regeneration even at near-zero driving force, challenging established electron transfer theories [2]. Electrochemical impedance spectroscopy has elucidated the critical role of Lewis bases in modulating TiO₂ conduction band energetics and recombination kinetics [2,3]. This molecular-level understanding has facilitated the evolution from liquid electrolytes to solid-state hole conductors, culminating in "zombie" cells that retain efficiency post-electrolyte solidification [1,4]. Scalability has been demonstrated with 3.2 cm² active areas maintaining 37.1%, 34.8%, and 33.7% efficiencies at 1000, 500, and 200 lux, respectively [2].

The seamless integration of these advanced IPV cells with microelectronics has propelled IoT capabilities from basic wireless communication to sophisticated on-device machine learning. A 7-cell array (22.4 cm²) now powers an ESP32 microcontroller executing Long Short-Term Memory (LSTM) neural networks, achieving 93.5-100% accuracy in deployment scenario prediction and performing up to 0.560 VAX MIPS [2,5].

This multidisciplinary synergy - from molecular design to materials engineering, device optimization, and edge computing implementation - exemplifies the transformative potential of chemistry-driven innovation in sustainable technology. The convergence of diffuse light harvesting, and artificial intelligence paves the way for autonomous, energy-efficient IoT ecosystems with far-reaching implications for smart infrastructure and sustainable digital transformation.

- [1] Michaels et al., Chem. Sci., 2020, 11, 2895-2906.
- [2] Michaels et al., Chem. Sci., 2023, 14, 5350-5360.
- [3] Zhang et al., Nat. Commun., 2021, 12, 1777.
- [4] Cao et al., Nat. Commun., 2017, 8, 15390.
- [5] Freitag et al., Nat. Photonics, 2017, 11, 372-378.