

Vacuum Pouch Sealing and Polymer Electrolyte Integration for Scalable DSSC Fabrication

Serena Amenta^{1,2*}, Roberto Speranza¹, Pietro Zaccagnini¹, Alessandro Pedico³, Valeriy Kapelyushko⁴, Chiara Bisio², Leonardo Marchese², Andrea Lamberti¹

¹*Politecnico di Torino, Dipartimento Scienza Applicata e Tecnologia, Via Duca degli Abruzzi 24, Torino, Italy.*

²*Università degli Studi del Piemonte Orientale "Amedeo Avogadro", Dipartimento di Scienze e Innovazione Tecnologica, Viale Teresa Michel 11, Alessandria, Italy.*

³*INRiM - Istituto Nazionale di Ricerca Metrologica, Str. delle Cacce, 91, Torino, Italy.*

⁴*Syensqo Viale Lombardia, 20, 20021 Bollate, Italy.*

*Corresponding author: serena.amenta@polito.it.

Dye-Sensitized Solar Cells (DSSCs) are promising energy harvesting systems, particularly suitable for low power, portable applications such as sensors and Internet of Things (IoT). These devices typically operate in environments with low light intensity or where replacing batteries is impractical or inconvenient. However, some challenges remain, such as issues in fabrication, solvent evaporation, and sensitivity to moisture.

In this study we present a flexible DSSC sealed in a pouch cell, combining both flexibility and compact sealing typical of this encapsulation technique. This approach is largely used for many electrochemical devices but rarely applied to DSSC. To further optimize production, composite polymeric electrolyte is used. A polymeric matrix is here combined with hydrophobic silica particles and low evaporation solvent, reducing the risk of moisture contamination, improving the long-term stability of the electrolyte membrane by reducing shrinkage and increasing electrolyte retention over time. By addressing the manufacturing challenges associated with the introduction of a liquid electrolyte, this approach facilitates production, as the membranes can be easily cast directly onto the electrodes. Furthermore, the use of these membranes improves sealing, thereby reducing the risk of short circuits.

The preparation in a flexible configuration, better adapts to integration with a storage system. Indeed, the possibility of merging the intermittent and environmental dependent energy harvesting with a storage system such as supercapacitors further enhances the applicability of these systems. This approach provides a smart solution to optimize the fabrication and the efficiency of energy harvesting and storage system for low power applications.