

Modernizing photovoltaic textiles for scalability and wearable applications



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Abstract

Thanks to photovoltaic (PV) textiles, solar power can be harnessed in new ways such as in bags, cloths, curtains, tents, sails, or construction tarps. However, the existing options for PV cells are either too expensive or not scalable. Using inkjet printing, an affordable and widely used technique in the textile industry, we can fabricate PV cells on large textile surfaces. It would contribute to modernize Portuguese textile manufacturing and promote sustainability, or even eco-tourism. In this proposal, we outline the steps involved in our solution and how we plan to collaborate with academia and industry in Portugal to make this a reality. Ultimately, this project can participate in making Portugal a hub for high-tech innovation and revolutionize human-computer interfaces such as self-powered smart sensing gloves for Augmented/Virtual Reality (AR / VR).



Fig 1: Illustrating the potential of scalable printed textile solar panels. From left to right: A construction wrapping tarp, a greenhouse.

Objectives

1. Optimize the inkjet printing process parameters, such as ink composition, printing speed, and drying conditions, to achieve high-quality PV textiles with good electrical properties and mechanical stability.
2. Investigate the compatibility of different textile materials with the inkjet printing process and identify the best-suited materials for PV textiles.
3. Characterize the performance of the PV textiles, including their power conversion efficiency, durability, and resistance to environmental factors such as light, moisture, and temperature.
4. Develop scalable manufacturing processes for producing PV textiles using inkjet printing, and evaluate their economic feasibility and environmental impact.
5. Explore potential applications for the PV textiles, such as wearable electronics, smart textiles, and building-integrated PVs, and assess their market potential and customer needs.
6. Collaborate with industry partners to ensure the successful commercialization of the PV textiles and facilitate their adoption in various sectors.



Fig 2: Illustrating the potential of printed textile solar panels. From left to right: An inkjet textile printer, and a smart glove.

Plan

Step 1: Replication, Characterization, and Comparisons.

The first step involves the replication of PV cells on rigid substrates using existing approaches. We will start with DIY PV fabrication techniques, such as organic/perovskite and dye-sensitized solar cells (DSSC). The PV cells will be characterized, and the most scalable approaches will be pre-selected for further development.

Step 2: Adapting the Process to Make it Robust and Scalable.

The adaptation the PV cell fabrication process for inkjet printing technology will require developing suitable inks, optimizing the printing process, and fine-tuning the process for large textile surfaces. Computational fabrication techniques and silicon-based materials may also be used to improve the performance of the PV textiles.

Step 3: New Applications.

The large textile surfaces will be explored for real-world applications, such as curtains, and other textile-based products (fig 1). We will also explore self-powered [7] sensing eTextile devices, such as data gloves (fig 2).

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