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SESSION: *Advanced materials for energy conversion and storage*

Preference: ORAL presentation

Advanced nanomaterials for energy harvesting and storage: the happy marriage of dye-sensitized solar cell and supercapacitors

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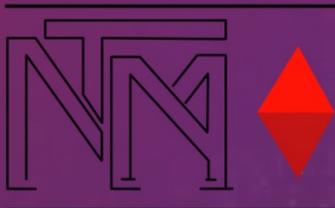
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In recent years the scientific community showed a growing interest toward the fabrication of dual systems able to harvest photovoltaic energy and directly store it within the same device. The integration between energy harvesting and storage (H&S) technologies is a must toward clean energy production and it becomes more appealing considering the possibility of producing electricity not only from direct sunlight but also from diffuse light and indoor illumination. Moreover, this duality becomes even more compelling if the growing number of portable connected devices is considered: all these devices need energy and a sustainable and portable power system surely represent an appropriate solution to provide it.

Among different kinds of photovoltaic technologies, dye-sensitized solar cells (DSSCs) showed an impressive light-to-energy conversion efficiency when employed under low-light illumination, diffuse solar radiation and indoor light sources. Moreover, low temperature- and atmospheric-pressure-based manufacturing processes make them compatible with roll-to-roll fabrication. This makes DSSC an attractive alternative in the landscape of recovering energy from diffuse and indoor illumination and directly power low-consuming devices (e.g. Internet of Things devices).

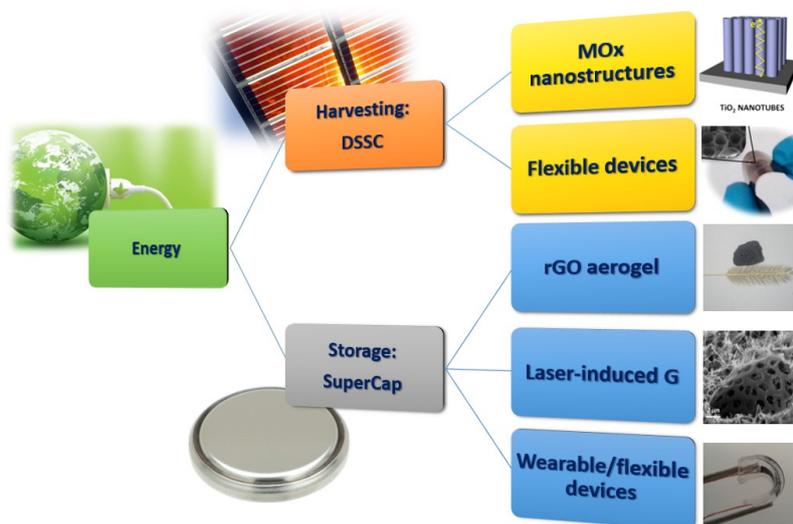
For the storage section, supercapacitors (SCs) represent a promising solution since they can sustain an incredible number of cycles without appreciably changing their performance value and they are less sensitive to the voltage output fluctuations of the harvesting section. These two features are absent in batteries and perfectly match with the intermittent character of photovoltaic energy production. For this reason, despite having a lower energy density than batteries, SCs are often preferred as the storage technology for integrated H&S devices.

In this context, nanostructured materials represent a huge class of interesting candidates to overcome the actual limitations of several energy technology fields. I will present the most important results obtained by Materials and Processes for Micro and Nanotechnologies Group at Politecnico di Torino (MP4MNT@PoliTO, <https://areweb.polito.it/ricerca/micronanotech/main-page>) about nanomaterials for energy harvesting and storage applications focusing the attention on some metal-oxide (such as TiO₂ and ZnO) and graphene-based materials (like rGO aerogel and laser-induced graphene) and in particular their application in dye-sensitized solar cells [1], supercapacitors [2] and their integration for portable harvesting and storage systems.[3]



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References

- [1] A. Lamberti et al. *Progress in Photovoltaics: Research and Applications*, 22 (2014) 189-197
- [2] A. Lamberti et al. *Advanced Energy Materials*, 6 (2016) 1600050
- [3] A. Scalia et al. *Journal of Power Sources* 359 (2017) 311-321

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