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WHISPERING GALLERY PHOTOVOLTAIC NANO-FIBER ARRAY

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Inefficient energy harvesting is inherent to fixed PV installations; about 40% of the luminous energy from the sun is missed if no tracking system is applied. However, a mechanical tracking of the sun requires regular maintenance and the costs of such technology are higher than the benefits obtained. Some approaches have been considered to enhance light harvesting at large angle incidence: in a system of an array of linear lenses, or other types of curved surfaces such as spheres. In the latter, the authors claimed that the more effective coupling originated from whispering gallery (WG) modes inside the spheres.

In the current project we proposed the use of WG coupling in a novel configuration based on implementing a thin film cell on the backside of an array of parallel fibers. We performed numerical calculations using the parameters of a thin film organic cell which demonstrate that light coupling becomes more effective as the angle for the incident light relative to the fiber array normal increases up to an optimal angle close to 55 deg. At this angle the power conversion efficiency of the fiber array solar cell we propose becomes 30% times larger than the one form an equivalent planar cell configuration. We demonstrate that the fiber array solar cell we propose may track the sun movement for over 100 degrees without any mechanical help. In addition, in the event that such fiber array cell would be installed with the adequate orientation on a vertical façade, an optimal photon-to-charge conversion would be reached for sunlight incident at 55 deg with respect to the horizon, very close to the yearly average position for the sun in the largely populated belts on the northern and southern hemispheres.

1. J. Gilbert. Patent Application FR 2 896 596-A1, filed January 26, 2006.

2. J. Grandidier, D. M. Callahan, J. N. Mundday, H. A. Atwater, Adv. Mater. 2011, 23, 1272.