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Short Description of Research Activity – Dr. Avi Niv

Dr. Niv heads the light-matter interaction laboratory at the solar cell center of the Sde-Boker Campus of Ben-Gurion University in the Negev. As such Dr. Niv is active in both the *solar-cell* and the *physical-optics* fields. *In the field of solar-cells* Dr. Niv investigates advanced light-management techniques for future ultrathin solar-cell technologies. Light-management refers to the collection of techniques aiming at boosting the efficiency of a solar cell by perfecting its optical performance, this in contrast with the more common approach of concentrating on material aspects instead. With cost effectiveness and sustainability in mind, the above mentioned "material" approach has yielded in recent years many conceptual technologies such as organic, compound-semiconductors, oxide-based, or quantum-dots or -wires solar-cells. A relatively common feature to many of these approaches, however, is their poor charge transport abilities that reduced active layers to sub-micron thicknesses. On one hand, this can be considered a favorable outcome as it lessen material usage, but on the other, thin active layers suffers from low optical absorption and therefore also form low output power efficiency. The current state-of-affairs is that this low efficiency makes more traditional, non-sustainable, approaches such as silicon based PVs dominate the consumption market. One way of overcoming this obstacle is by somehow "perusing" more light to go into the ultrathin active layer. This negotiation, however, is not easy. After all, nano-scaled thicknesses mean that traditional light management technics, so instrumental in solar cell industry, cannot be applied. Accordingly, Dr. Niv investigates approaches form the realm of nano-optics such as photonic waveguiding and total internal light randomization. Such approaches are indispensable for bringing novel sustainable cost effective technologies to commercial availability. *In the field of physical optics* Dr. Niv investigates a new approach to nonlinear optics in meta-molecules and metamaterials. Nonlinear optics emerges when excitation of a material system at a certain wavelength yields luminescence at higher harmonics of that fundamental stimulus. Metamaterials are manmade nano-scaled composites that can deliver unprecedented optical activity, such as negative refractive index. Here, it is shown that bulk oscillations of free-electrons in the nano-inclusions that compose the metamaterials can generate nonlinear optical activity that surpasses that of natural materials. Nonlinear light-matter interaction is instrumental for demanding applications such as beyond-the-diffraction-limit microscopy and optical communications. It is further hopped that having much stronger nonlinear optics would benefit technologies that did not consider this type of light-matter interaction so far, such as solar cells.