Titre Thèse **Title**	**Deep learning metasurfaces for energy harvesting**	
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Abstract: The objective is to engage in an **innovative basic and applied research effort** in order to investigate **deep learning for the formation of all-dielectric metasurfaces** for use as high temperature emitters for energy harvesting with thermophotovoltaics (TPV). An issue with current TPV systems is the lack of discrimination between energies with respect to the bandgap energy of the cell. Thus, typically these systems require filters inserted in-between the absorber and TPV Cell to reject unwanted light incident on the cell. In principle all-dielectric selective metasurfaces can be used for emitters in TPVs, but complex inter-unit cell effects lead to non-linear interactions and spectral shifting, thus making conventional design optimization impossible. Research in all-dielectric metasurfaces currently uses relatively simple unit-cell designs, but increased geometrical complexity is needed to achieve the required highly tailored emission in the infrared range of the electromagnetic spectrum.

Machine learning has recently been applied to the design of metasurfaces with impressive results, however the much more challenging task of finding a geometry that yields a desired spectra remains largely unsolved. We propose a method capable of finding accurate solutions to the ill-posed inverse problem, where a metasurface geometry is sought which yields a radiant exitance matching the external quantum efficiency of III-V semiconductors for TPVs. Our approach involves developing an accurate feed forward neural network model, which leans the function mapping the metasurface geometry to emissivity spectrum. The proposed inverse method finds the optimal inverse solution by fixing all the weights and biases of the forward model, and computes the forward model's gradient solely with respect to the input of the network, which in this case is the metasurface geometry. The desired metasurface geometry will be evaluated iteratively until a convergence criterion is satisfied.

Willie Padilla is a Professor at **Duke University (USA)**. He is a one of the world leaders in the fields of **Metamaterials and Metasurfaces** and particularly at **Terahertz** frequencies. He is also a world expert in the fields of **imaging**, and **deep learning** for **energy harvesting** and **metasurface based biodectors.**
(h-index=68 and more than 47 500 citations).
https://scholar.google.fr/citations?user=5mFPlG0AAAAJ&hl=fr&oi=ao

Tahsin Akalin is an Associate Professor. He is an expert in the field of **terahertz** electromagnetic waves, photonics, **plasmonics**, Planar Goubau Lines, antennas, **metasurfaces** including for **biosensing** applications and wireless communications (5G, 6G and beyond).
(h-index=24 and more than 2 400 citations).
https://scholar.google.fr/citations?user=YFx_xtsAAAAJ&hl=fr&oi=ao