Photon-enhanced thermionic emission for space power systems

Efficiency study and FEM modelling

Executive Summary

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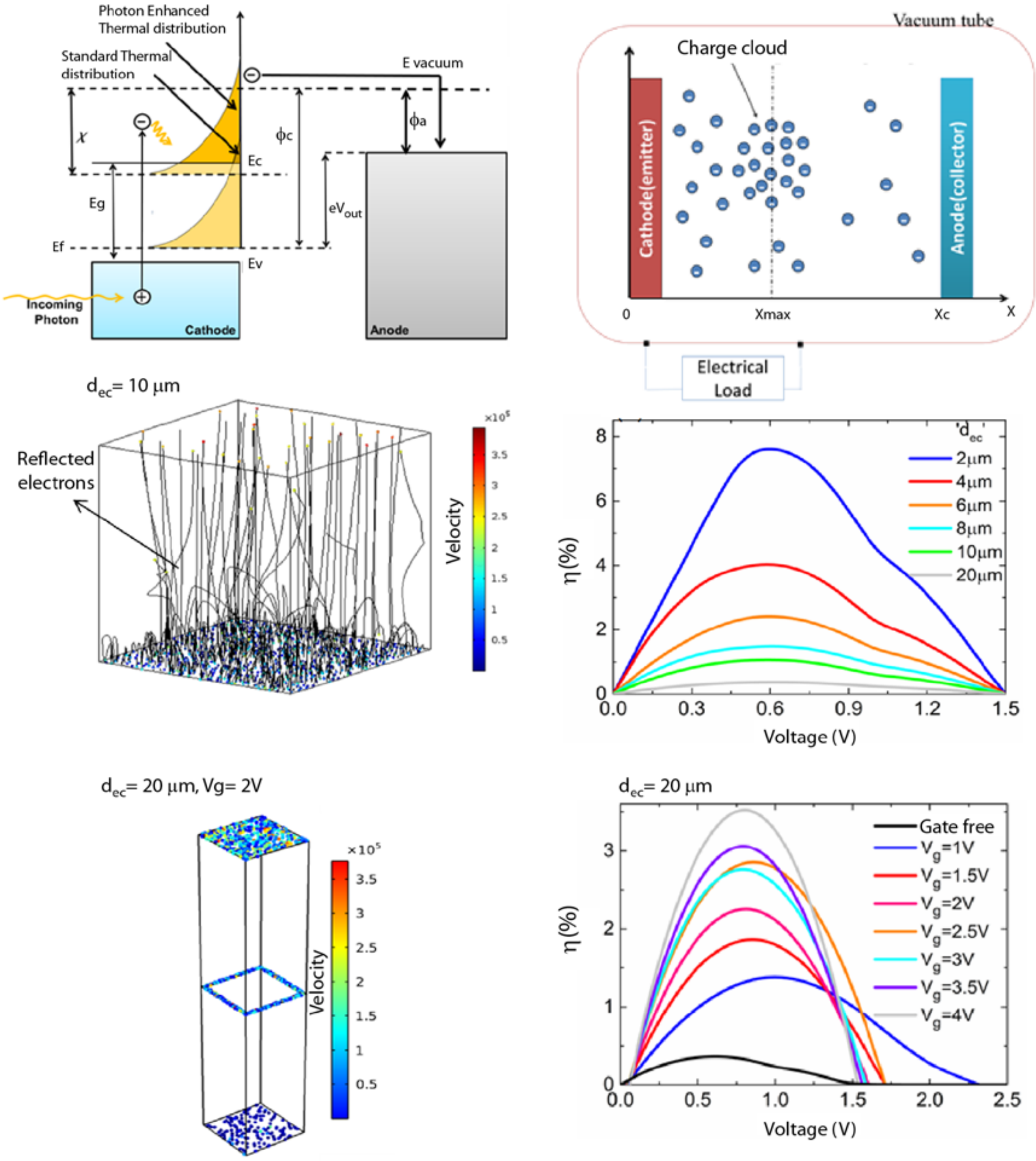
Picture:



Motivation:

To investigate the combination of thermal and photovoltaic effects towards an high efficient photo-to-energy conversion device.

Methodology:

We used numerical simulations based on FEM technique. In particular, we addressed the charge cloud issue in a fully 3D fashion to be able to design and simulate devices as close as possible to reality.
After initial tests based on analytical and 1D numerical techniques, we moved to the 3D device where we investigated the role of cathode-anode

distance in terms of conversion efficiency. Afterwards, we verified the advantage of using a gate as well as nanostructuring of the cathode face always in terms of device efficiency.

Results:

- The most effective method to increase the efficiency is to reduce the cathode-anode distance. A value of 2μm can be considered a valuable target.
- The gate can play an important role in the efficiency enhancement. However, it might be of difficult realization especially for small cathode-anode distances.
- The nanostructuring of the cathode face does not play any important role in the efficiency enhancement.

Publications:

1) Manuscript on "charge cloud effect" is under preparation;
2) Jerónimo Buencuerpo, José M Llorens, Pierfrancesco Zilio, Waseem Raja, Joao Cunha, Alessandro Alabastri, Remo Proietti Zaccaria, Antonio Martí, Thijs Versloot, Light-trapping in photon enhanced thermionic emitters, Opt. Exp. 23, A1220-A1235 (2015).

Highlights:

We have developed a tool capable of simulating the vacuum chamber of a PETE device. Our tool is very robust, numerically efficient and it can take into account a number of material/geometrical constrains (e.g., we have tested it with structures showing a cathode-anode distance from 2μm to 50μm). The next step will be the integration in our tool of the last missing actor, meaning the anode. By doing so we expect to have a "product" capable of providing, though a numerical hence cheap approach, the output of any kind of vacuum chamber.