A novel concept based on thin film silicon triple-junction solar cells simultaneously generating solar electricity and hydrogen

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**MOTIVATION**

Daily rated power of a 5 kWp solar plant superimposed on the average power consumption of a 4-person household on a summer day:

The ‘Achilles’ heel’ of photovoltaic (PV) energy generation is the non-uniform electricity generation. Accordingly, the direct combination of a PV system with an energy storage component appears desirable. Hydrogen can be stored, shipped and combusted without harmful reactants. Moreover, it can be produced by renewable energy sources, such as light-induced water splitting.

**INTRODUCTION**

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**NOVEL CONCEPT BASED ON THIN FILM SILICON TRIPLE-JUNCTION SOLAR CELLS**

- Solar cells based on stacks of hydrogenated amorphous silicon (a-Si:H), silicon germanium (a-SiGe:H), and nanocrystalline/microcrystalline silicon (nc-Si:H/[μc-Si:H])
- Amorphous silicon triple-junction solar cells, as for example a-Si:H/a-SiGe:H/nc-Si:H or a-Si:H/a-SiGe:H/a-SiGe:H can supply open circuit voltages of up to 2.3 to 2.5 V as given below.

![Schematic of the novel concept](image)

**MODELING AND SIMULATION**

- Different combinations of a-Si/a-Si/a-Si device configurations were evaluated by using wxAMPS (https://wiki.engr.illinois.edu/display/solarcellsi/m/SimulationSoftware).
- Idealized a-Si p-i-n and p-i-n/p-i-n – structures were used as device structures, and the general ‘default’ physics parameters from the software were chosen.
- **Modeling parameters:**
  - p-i-n junction: Top Middle Bottom
  - Energy gap [eV]: 1.8 1.6 1.4
  - i-layer thickness [nm]: 90 380 380
  - p/n-lay. thickness [nm]: 10/10 10/10 10/10

**RESULTS & CONCLUSION**

- **A novel concept based on a-Si:H triple-junction solar cells and a solar water splitting system integrating a PEM electrolyser is presented.**
- It is possible to achieve a sufficient voltage of greater than 1.5 V with the top dual junction ($E_G=1.8$ eV and $E_G=1.6$ eV) of a triple junction a-Si based solar cell (figure a).
- The corresponding J-V characteristics of a-Si p-i-n single junction ($E_G=1.4$ eV) usable for PV electricity generation is given in figure b.
- Additional modeling has to be done to clarify the applicability of an a-Si based cell regarding simultaneous generation of electricity & hydrogen.

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