

# Report for the short visit grant

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Title of the project: Donor antenna sensitizers for dye sensitized TiO<sub>2</sub> solar cells

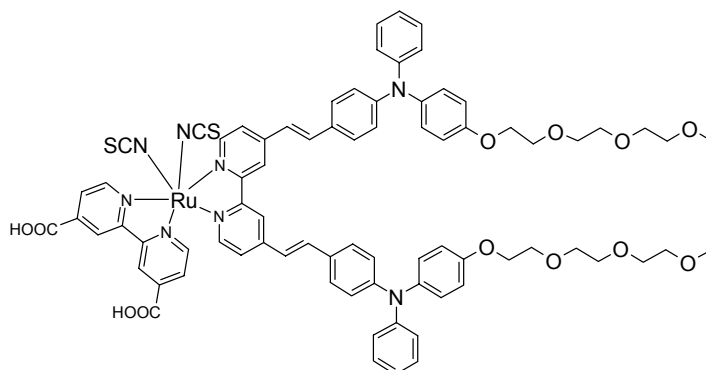
Dates: 1.7.07 to 7.7.07

Host Institute: Laboratory for Photonics & Interfaces, Swiss Federal Institute of Technology (EPFL) CH 1015 Lausanne, Switzerland

Guest Institute: University of Bayreuth, Germany

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Emerging photovoltaics such as dye-sensitized photovoltaic devices involving molecular dyes and mesoporous nanocrystalline titania have attracted greater attention in industry and academics due to their great potential to convert solar energy into electrical energy at low cost<sup>1</sup>. Donor antenna sensitizers have great potential in dye-sensitized solar cells (DSSC) as they possess high molar extinction coefficients and these dyes retard the charge recombination in solid-state dye-sensitized solar cells<sup>2,3,4</sup>. A new donor antenna dye with ethylene oxide units attached to the donor moiety (Figure 1) has been synthesized and characterized at University of Bayreuth.



**Figure 1 Structure of donor antenna dye with ethylene oxide units**

A comparative study of dye-sensitized solar cells based on this new dye using three different hole transporting systems namely, I<sup>-</sup>/I<sup>3+</sup> electrolyte, ionic liquid (propylmethylimidazoliumiodide) and Spiro-OMeTAD (solid-state hole conductor) was carried out at EPFL, Lausanne in the group of Prof. M. Grätzel. Dye sensitized photovoltaic devices were prepared according to the standard method reported earlier<sup>5</sup>. The electrolyte solution is comprised of 0.6M M-methyl-N-butyl imidazolium iodide (BMII), 0.04 M iodine, 0.025 M LiI, 0.05M guanidinium thiocyanate and 0.28 M tertiary butylpyridine in 15/85 (v/v) mixture of valeronitrile and acetonitrile). The active area of DSSCs was 0.20 cm<sup>2</sup>. In the case of ionic liquid in addition to the electrolyte system mentioned above, propylmethyl imidazoliumiodide (PMII) and N-butylbenzimidazole were added in the system. Spiro-

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OMeTAD with dopants such tert-butylpyridine and Li salt were use as the solid-state hole conductor. as was used. The photovoltaic performances (measured using 450 W xenon light source, under AM 1.5 conditions) of this new donor antenna dye using liquid electrolyte, ionic liquid and solid-state hole conductor are given in Table 1.

**Table 1** Photovoltaic performances of DSSCs using Ru-TPA-NCS and Ru-bpy-NCS dyes under AM 1.5 full sunlight (100 mW cm<sup>-2</sup>).

Hole transporting materials	Voc [mV]	Jsc [mA/cm <sup>2</sup> ]	FF [%]	η [%]
I <sup>3-</sup> /I <sup>-</sup>	672	17.1	70	8.1
PMII	650	11.9	70	5.5
Spiro-OMeTAD	872	6.40	61	3.4

It is evident from the Table that the donor antenna dye performs extremely well in all three types of DSSC. This may be attributed to its very high molar extinction co-efficient and its ability to retard the charge recombination at the interface. In conclusion, a biypridyl ruthenium complex with donor antenna unit such as triphenylamine containing ethylene oxide units with enhanced harvesting of visible light was synthesized and demonstrated as a highly efficient sensitizer for nano-TiO<sub>2</sub> dye sensitized photoelectrochemical solar cells. Therefore, the visit to EPFL was fruitful and the author would like to thank ESF for providing a research grant for this visit.

## References

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