

X-ray spectroscopy studies of laser-induced RGO for **CIGS/perovskite tandem solar cells**

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Introduction

To optimize the efficiency of the tandem solar cell, the energy levels of the recombination layer have to perfectly match those of the other layers of the device. In this context, reduced graphene oxide (RGO) is a promising material to use in CIGS/Perovskite tandem solar cells.

So, the modulation of the degree of reduction of RGO is an important variable in its application in tandem solar cells.

In this work, we studied the evolution of the GO properties reduced by different number of laser

Methods



0, 1, 3, 10, 50, 100, 300, 500, and 1000 laser pulses (GO., RGO1LP, RGO3LP, RGO10LP, RGO100LP, RGO300LP, RGO500LP and RGO1000LP) The evolution of the electronic properties of the RGO was studied by **XPS** and **NEXAFS**; The work function wasestimated by Kelvin Probe; Sheet resistance was measured by four-probe point method.



NEXAFS: performed at the PEEM/XAS bemline, SOLARIS National Synchrotron Rradiation Centre (proposal number 202044 and 212016)

Laser fluence: 20 mJ/cm²

Results and discussion



- epoxide and hydroxyl groups
- Decrease in C=O and COOH (4 and 5)

- (**5** and **6**)

X-ray photoemission spectroscopy (XPS)



Sample	(2) C sp ³	(1) C sp ²	(3) C-OH/C-O-C	(4) C=O	(5) O=C- OH	C/
OLP	46.9	2.72	38.6	6.81	4.90	0.9

Work function



Conclusions

Summarizing, we can infer that the reduction takes place by removing the epoxide groups at the beginning of the reduction, generating randomly oriented hydroxyl groups in the graphene oxide sheets. The reduction further evolves to the formation of sp² conjugated carbons, which reduces the sheet resistance of the RGO. It is evident the relation between the reduction degree and the electronic properties of RGO. In this way, the findings presented here are important to prepare RGO films with the desirable propertie for PV applications.

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