ESPCI PARIS

EDUCATION SCIENCE INNOVATION

COMMENT UTILISER DES NANOPARTICULES D'OR POUR PRODUIRE DE L'ÉNERGIE ?

Julien Barrier, Simon Lottier, Baptiste Michon

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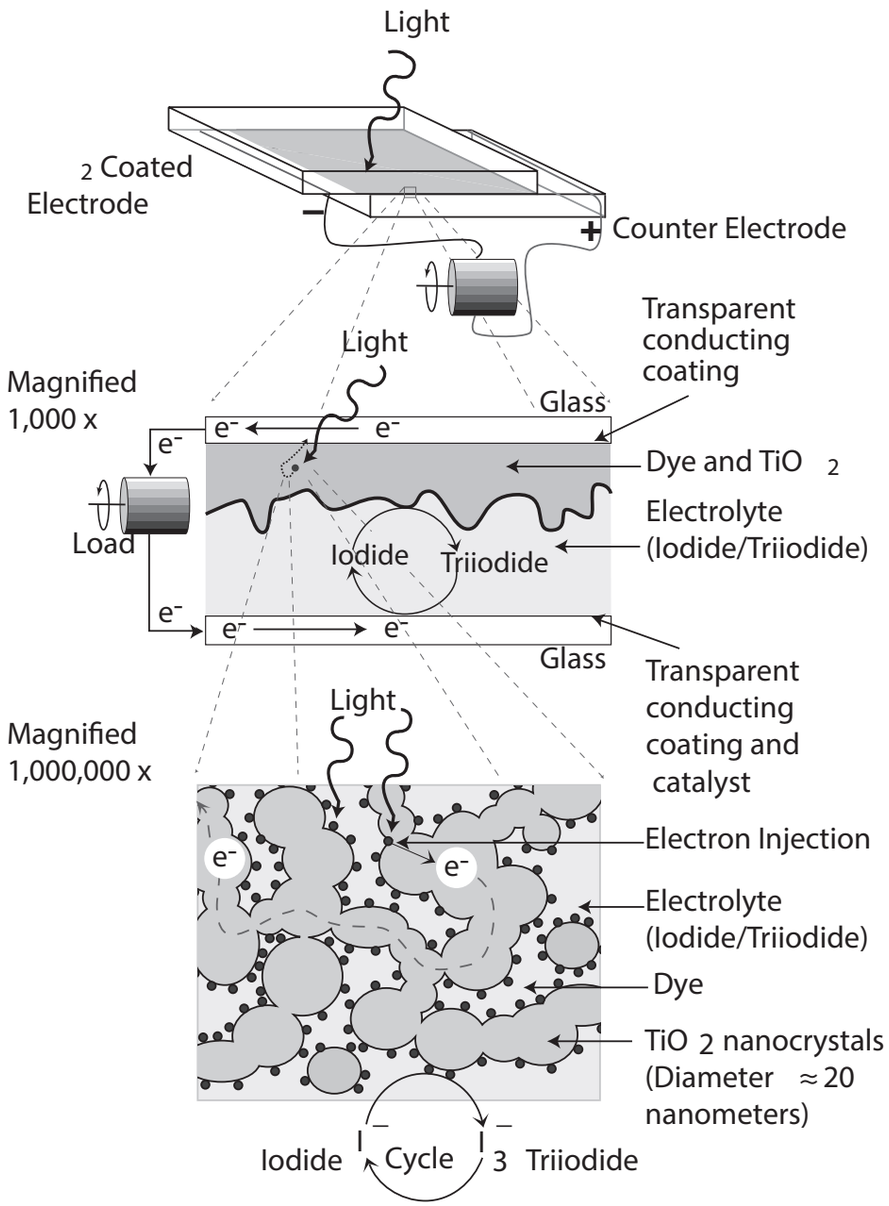
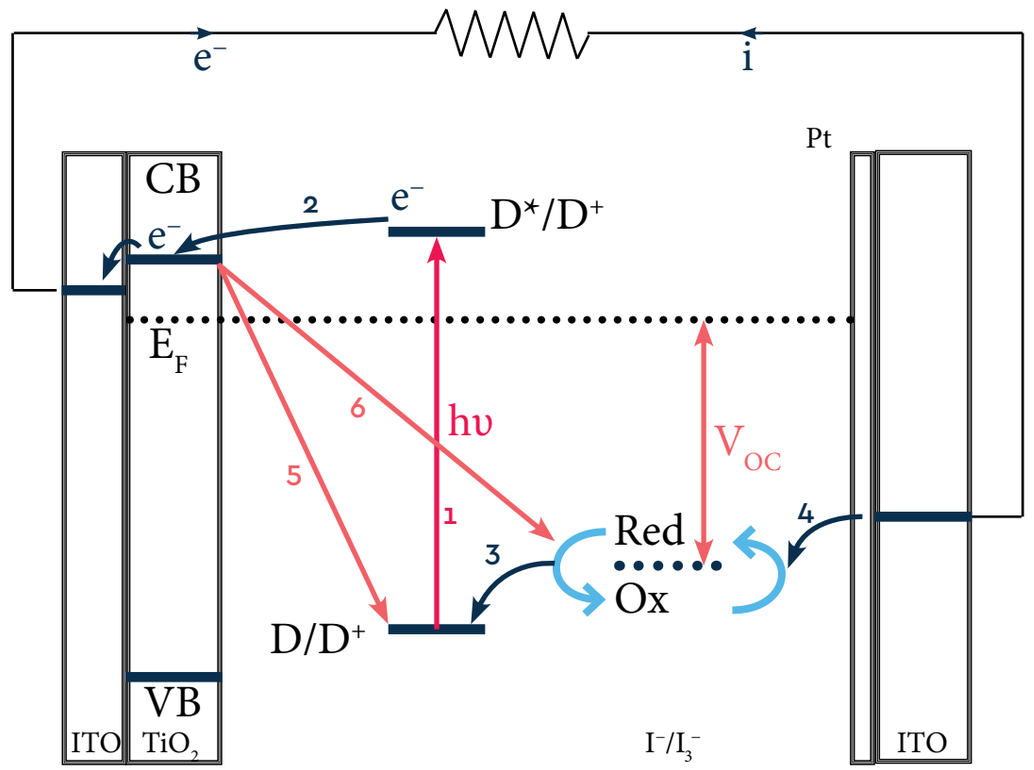
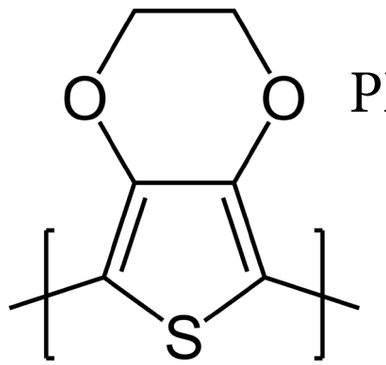
INTRODUCTION



Demonstrating Electron Transfer and Nanotechnology: A Natural Dye–Sensitized Nanocrystalline Energy Converter, Greg P. Smestad et Michael Grätzel, *Journal of Chemical Education*, 1998



photoanode colorant électrolyte contre-électrode semiconducteur



PEDOT:AuNPs

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COMMENT ON EN EST ARRIVÉ LÀ ?

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Gold nanoparticles and poly(3,4-ethylenedioxythiophene) (PEDOT) hybrid films as counter-electrodes for enhanced efficiency in dye-sensitized solar cells

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ABSTRACT

PEDOT films incorporating gold nanoparticles have been used for counter-electrodes in dye-sensitized solar cells. An increase in efficiency of about 130% has been observed compared to the use of PEDOT alone. Electrochemical investigations of the $Co^{III}(phen)_3/Co^{II}(phen)_3$ used as redox shuttle on the PEDOT-AuNPs and PEDOT electrodes point out towards neither an enhanced catalytic activity nor a plasmonic effect but strongly suggest that this enhanced power efficiency is due to an increase in the conductivity of the counter electrode. On a more general point of view, this study shows the important impact of internal ohmic drop inside a DSSC on its efficiency.

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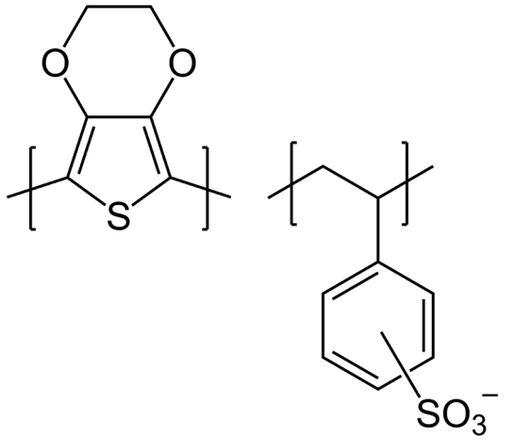
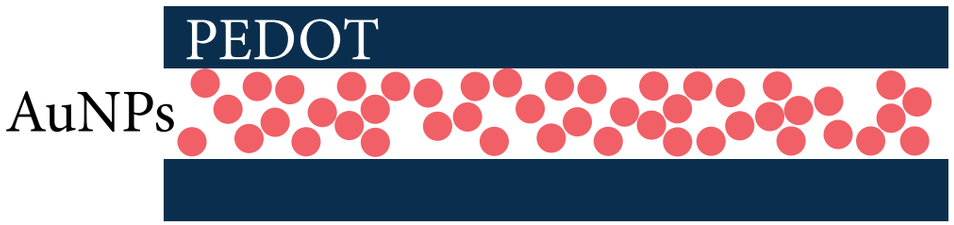
1. Introduction

Nowadays, solar energy appears as a green and renewable alternative energy source to fossil fuels. Photovoltaic cells are among the best devices of harvesting energy directly from sunlight. In particular, solid-state semiconductor cells based on p-n junctions and usually made of silicon have dominated the field of photovoltaic since its inception. Nevertheless, dye-sensitized solar cells (DSSCs), based on molecular components and proposed over two decades ago,[1] have emerged as a competent alternative technology to conventional semi-conductor devices. Indeed, DSSCs possess key attractive features such as their low cost, their ease of fabrication, and their powerful sunlight harvesting efficiency.[2,3] Moreover, their improved performance with diffused light and at high temperatures, and their negligible dependence on the incident light angle, are additional advantages over traditional semiconductor

a redox shuttle. Finally, the electrolyte is regenerated in turn by reduction at a counter-electrode (namely the cathode), the cycle being completed via electron migration through the external circuit. The voltage generated under illumination corresponds to the difference between the Fermi level of the electron in the TiO_2 layer and the redox potential of the electrolyte.

In many studies, the counter-electrode was a platinum-coated TCO electrode and the redox shuttle was the triiodide/iodide (I_3^-/I^-) redox couple.[1] Indeed, TCO electrodes have a very high charge transfer resistance, and it is necessary to reduced it, which is achieved by introducing a layer of catalyst on top of the TCO.[4] Platinum layers were currently used because of their high catalytic activity toward the reduction of I_3^-. However, platinum is a noble metal which is rare on earth and very expensive. Fabrication of counter-electrodes with alternative cheaper and more abundant





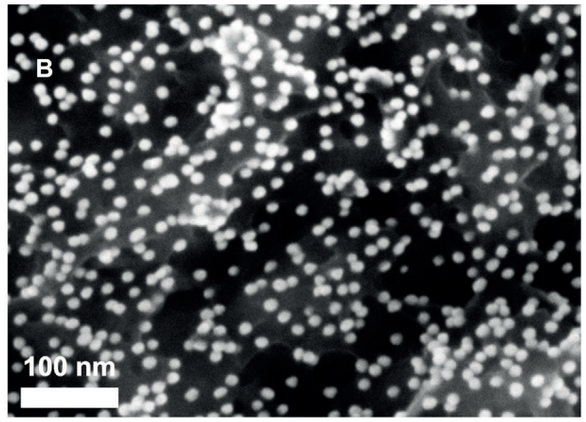


Figure 1. (A) Optical absorption spectrum of a PEDOT-AuNPs FTO electrode (FTO plate overcoated with PEDOT alone was used as reference to record the spectrum). (B) SEM image of a PEDOT-AuNPS FTO electrode.

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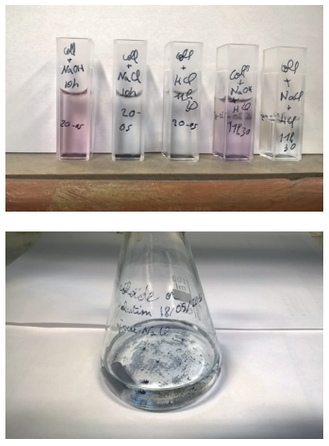
L'ÉVOLUTION DU PROJET

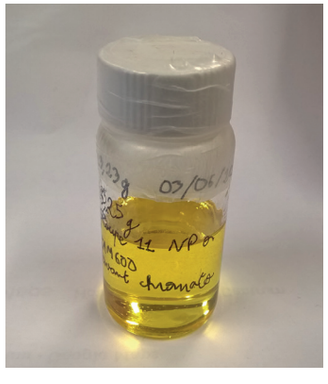
Julien Barrier @JulienBarrier — Suivre

Reprise des @PSE_ESPCI , on va tenter d'observer un effet plasmonique sur des nanoparticules d'or dans du PEDOT:PSS.

17:40 - 7 Oct 2016

1 3





Julien Barrier @JulienBarrier — Suivre

On commence les manips avec le PEDOT:PSS aujourd'hui ! @PSE_ESPCI

13:22 - 28 Oct 2016

1 2

Julien Barrier @JulienBarrier — Suivre

Direction @ipggmicrofluid pour la lithographie de nos électrodes en @PSE_ESPCI

15:41 - 28 Oct 2016

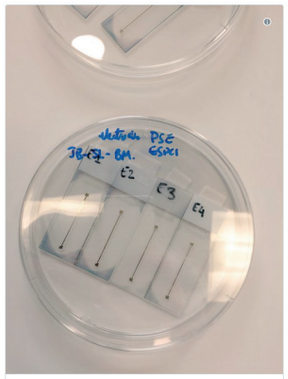
1 1

Julien Barrier @JulienBarrier — Suivre

Le masque de nos électrodes est fait, direction la salle blanche pour le coating de l'or en @PSE_ESPCI

15:55 - 28 Oct 2016

2 3

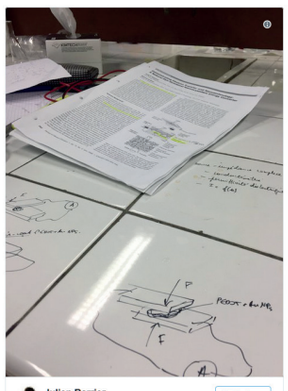


Julien Barrier @JulienBarrier — Suivre

Nos électrodes sont prêtes, on va pouvoir y spin-coater notre polymère-hybride PEDOT:PSS:AuNPs avant l'étude electrochimique @PSE_ESPCI

16:54 - 28 Oct 2016 · Paris, France

1 1



Julien Barrier @JulienBarrier — Suivre

Encore une journée @PSE_ESPCI où on avance pas mal !

17:13 - 18 Nov 2016 · Paris, France

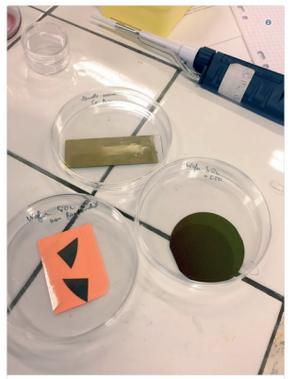
1 4

Julien Barrier @JulienBarrier — Suivre

Rendez-vous avec des chercheurs de l'ITODYS, @ParisDiderot pour en apprendre plus en vue de notre @PSE_ESPCI . Réflexions intéressantes !

16:31 - 10 Nov 2016

1 2



Julien Barrier @JulienBarrier — Suivre

Notre collection de substrats se complète ! @PSE_ESPCI

14:46 - 18 Nov 2016 · Paris, France

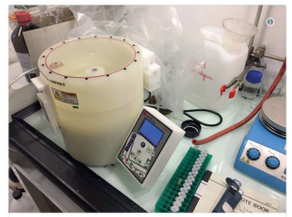
2 3

Julien Barrier @JulienBarrier — Suivre

C'est Noël avant l'heure en @PSE_ESPCI !

14:10 - 2 Dec 2016 · Paris, France

1 4

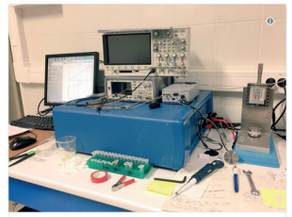


Julien Barrier @JulienBarrier — Suivre

Premiers essais de spin coating de PEDOT:PSS:AuNPs en @PSE_ESPCI !

16:43 - 4 Nov 2016 · Paris, France

1 1



Julien Barrier @JulienBarrier — Suivre

Mesures de conductivité, d'impédance complexe, de permittivité dielectrique et AFM : journée chargée en @PSE_ESPCI !

17:06 - 9 Dec 2016 · Paris, France

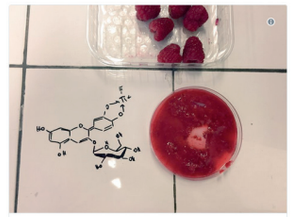
1 2

Julien Barrier @JulienBarrier — Suivre

@PSE_ESPCI : nos premiers résultats sont intéressants et encourageants !

18:12 - 9 Dec 2016 · Paris, France

1 2

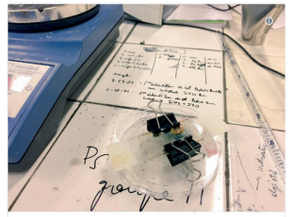


Julien Barrier @JulienBarrier — Suivre

On devrait former un complexe Cyanine-Ti(IV) en utilisant du jus de framboise, sûrement la source du problème @PSE_ESPCI #DSSC @ESPCI_Paris

17:26 - 27 Mar 2017 · Paris, France

2 4

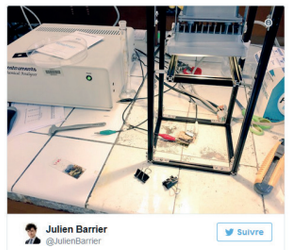


Julien Barrier @JulienBarrier — Suivre

On commence à faire des DSSC avec contre électrode en PEDOT:AuNPs pour la fin des @PSE_ESPCI : application de l'effet plasmonique.

16:14 - 10 Mar 2017 · Paris, France

2 2



Julien Barrier @JulienBarrier — Suivre

Essais sur des #DSSC en @PSE_ESPCI : pas vraiment fructueux... #photovoltaics #OrganicElectronics @ESPCI_Paris

16:58 - 27 Mar 2017 · Paris, France

2 5

Julien Barrier @JulienBarrier — Suivre

Tournage puis montage des vidéos pour les @PSE_ESPCI

19:37 - 10 May 2017 · Paris, France

5 9

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RÉSULTATS

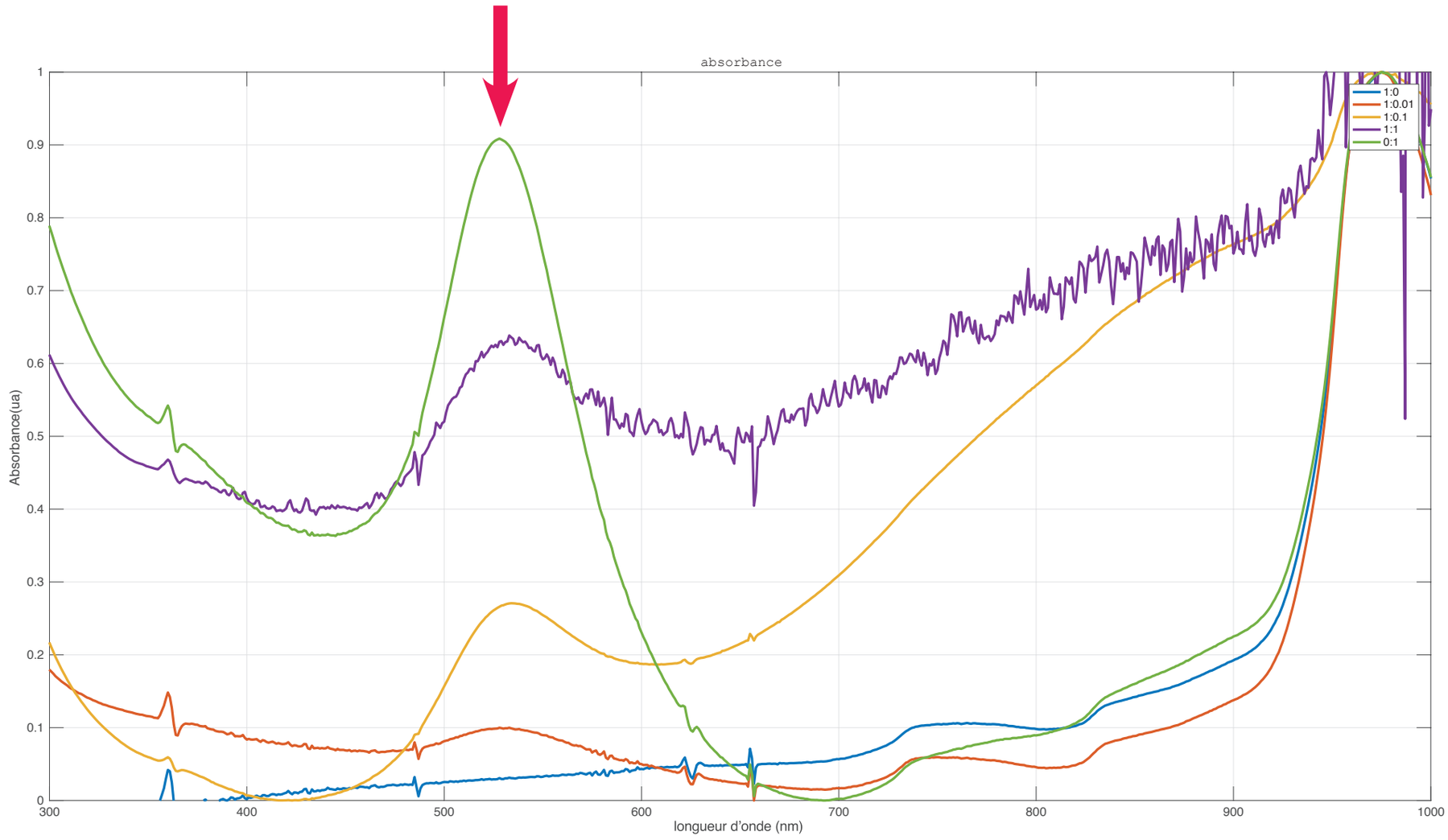


figure 1 : Absorbance UV-visible de plusieurs solutions PEDOT:AuNPs

RÉSULTATS

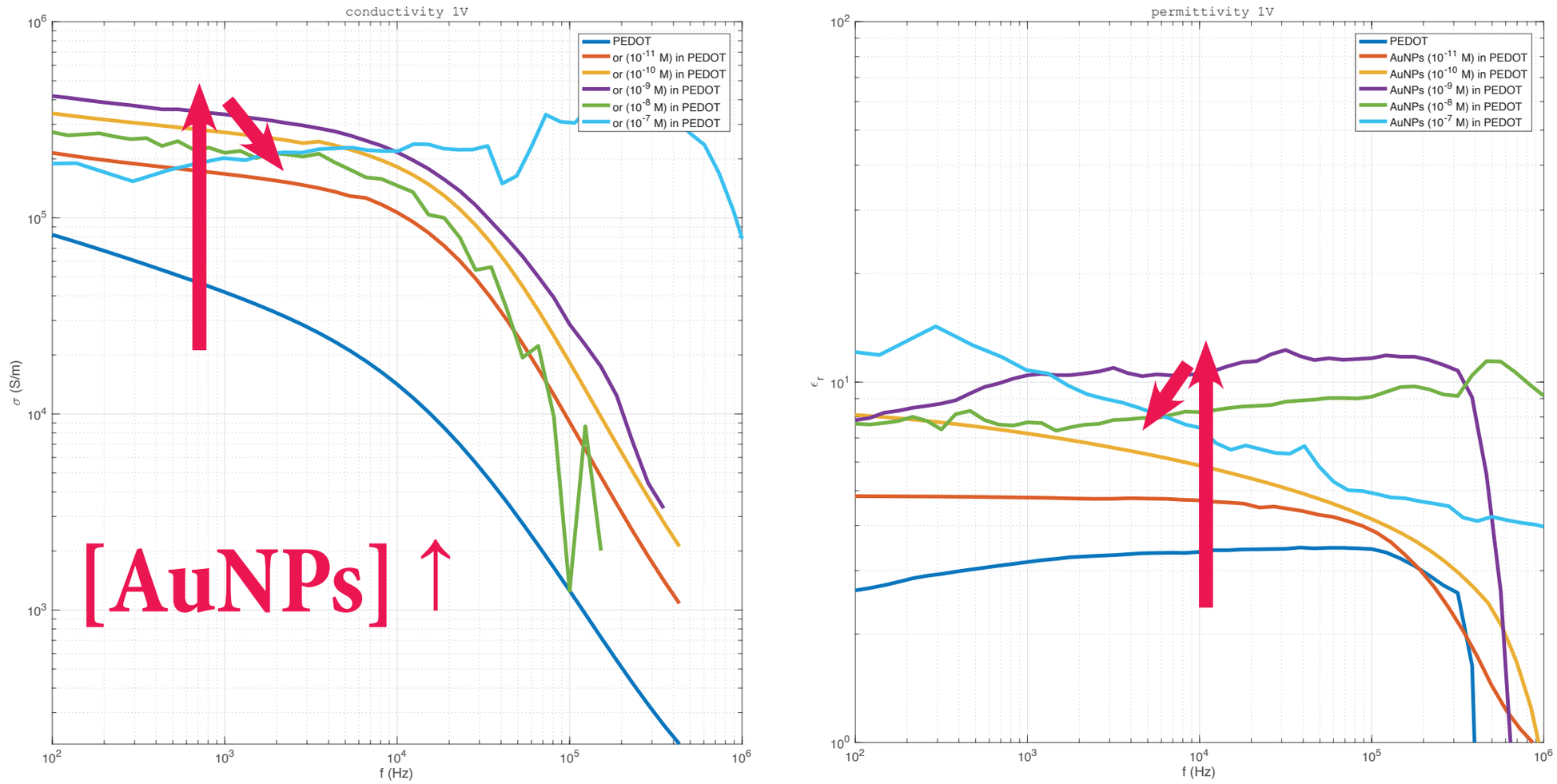
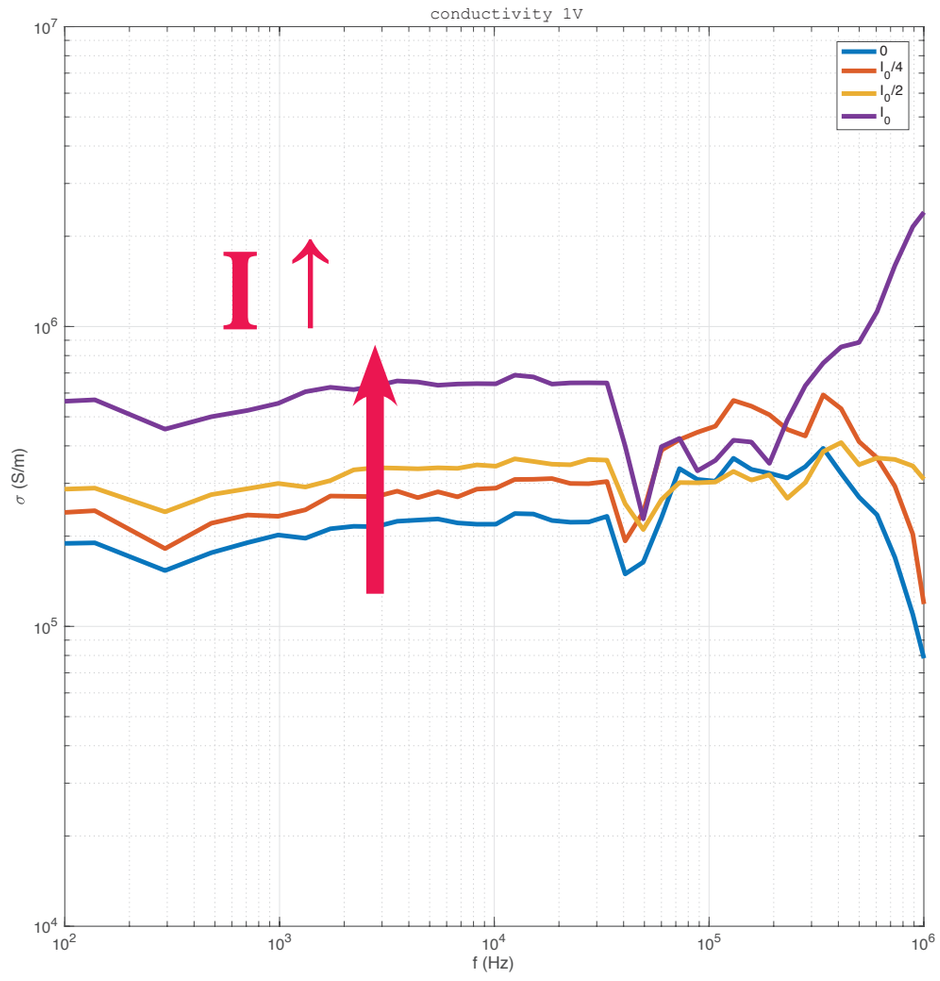


figure 2 : Conductivité et permittivité de films de PEDOT:AuNPs en différentes proportions

RÉSULTATS



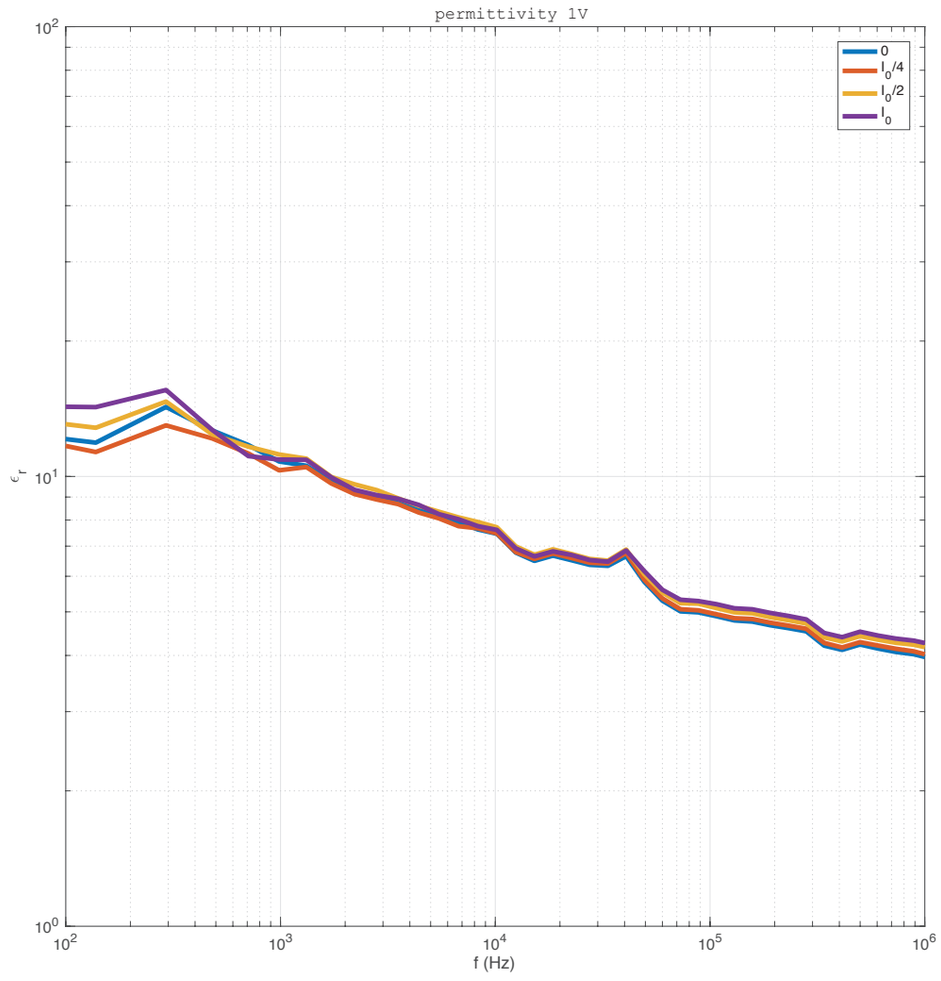


figure 3 : Conductivité et permittivité de films PEDOT:AuNPs pour différents éclairements

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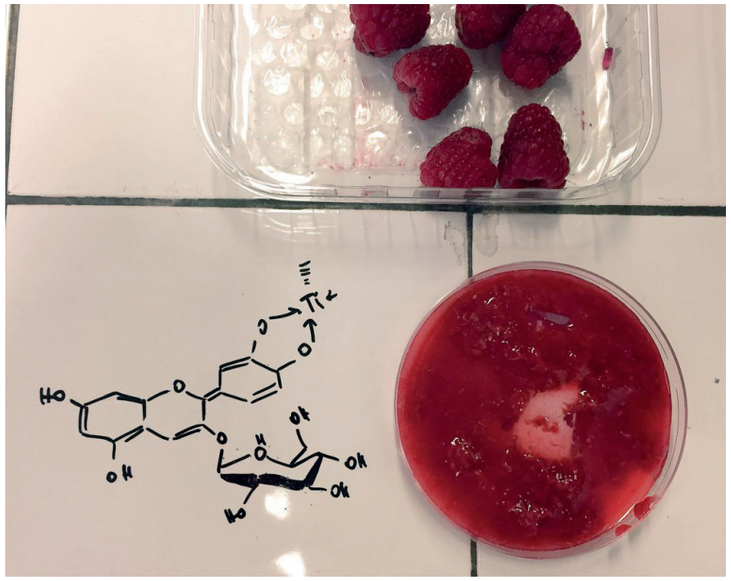
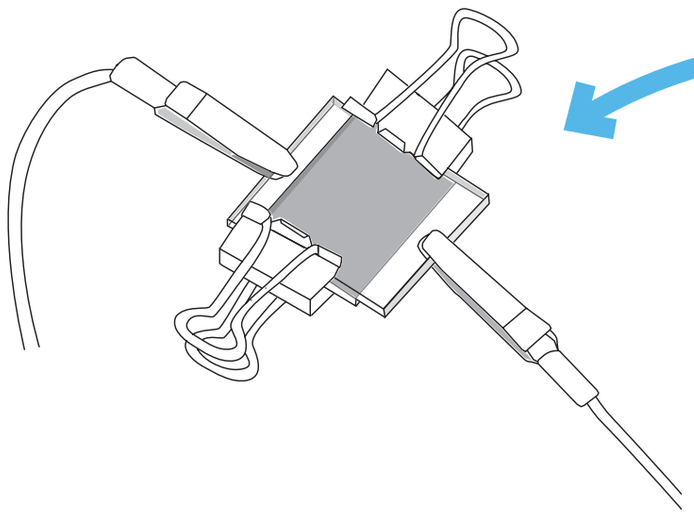
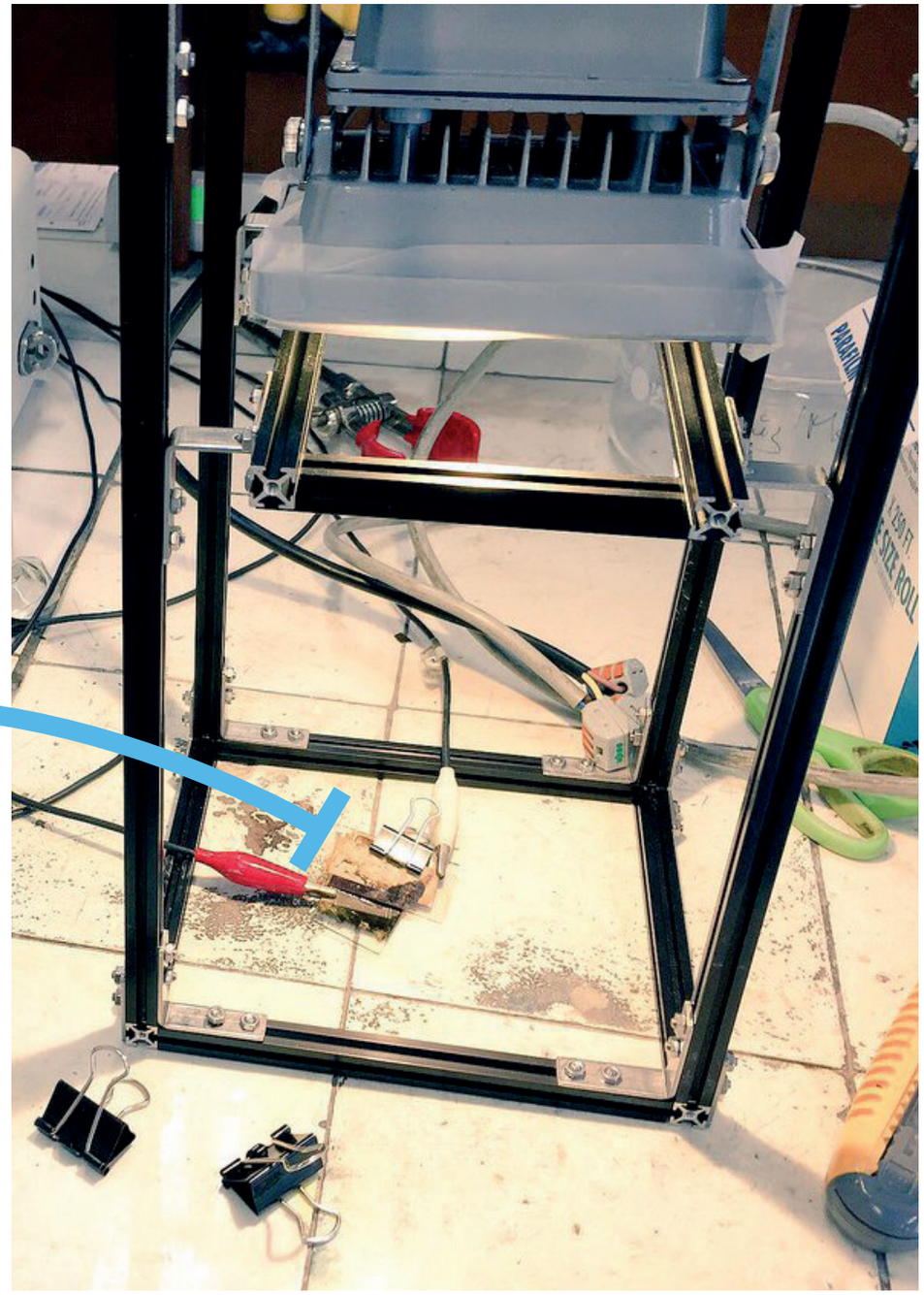
CONCLUSION







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