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# Furfuraldehyde : From plant harvest to light harvest?

Jérôme Husson[a,*], Jérémy Dehaudt[b], Laurent Guyard[a]

[a] Institut UTINAM UMR CNRS 6213, Université de Franche-Comté 16 Route de Gray, 25030 Besançon, France
[b] Department of Chemistry and Chemical Biology, University of New Mexico, Albuquerque, New Mexico 87131, United States

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ABSTRACT

Furfuraldehyde, which can be isolated from biomass such as corn, straw or wood can be used as a reagent in the preparation of valuable molecules. This short review emphasizes the utilization of furfural as a reagent in the preparation of functional molecules to be used in photovoltaic devices such as Dye-Sensitized Solar Cells or Organic Solar Cells. Different options are possible, the first one being the use of the furan ring as a latent carboxylic acid moiety in metal complexes to be used as sensitizers. The second is to use the furan ring as a part of the functional molecule. Owing to the rich chemistry of furan rings, an interesting diversity of chemical structures can be obtained from furfural through chemical synthesis.


**Contents**



## Introduction

Due to increasing focus on environmental problems and climate changes, and also diminishing fossil-fuel feedstocks, important efforts have been made to develop new devices for the production of energy. Amongst these, solar cells have been used to produce electricity from light [1]. Currently, most of the solar cells that are sold are based on silicon technology [2,3]. Nevertheless, alternative technologies have appeared more recently, with the aim of reducing fabrication costs of photovoltaic modules. Dye-Sensitized Solar Cells (DSSC) [4,5] and organic or polymer solar cells (OSC, OPV) [6] are examples of these new devices that can be used to generate electricity from the sun.

The DSSC concept was described in the 90s [7]. It relies on the use of a sensitizer (the "Dye") that is adsorbed onto a wide band-gap semiconductor such as $TiO_2$ in order to produce electricity from light. In organic or polymer solar cells charge separation occurs between a donor molecule and an acceptor molecule (Fig. 1). Molecules that are used in these devices range from metal complexes to organic complexes/molecules/compounds and polymers [8–10] (Fig. 2).

DSSCs and organic or polymer solar cells have the advantages of being easier to construct and of having a lower production cost when compared to silicon technology. This advantage is important in order to expand the use of solar electricity, especially in developing countries.

Many researchers have worked on preparing new molecules for application in DSSC, OSC or OPV. The goal they are pursuing is to improve cell efficiency and/or synthetic pathways [11]. Introduction of the principles of green-chemistry to the synthesis of such molecules is important in order to reduce the environmental impact of cell fabrication [12]. This short review emphasizes the use of furfural as a reagent in the synthesis of such molecules to be used in photovoltaic devices.

* Corresponding author. Tel.: +33 3 81666291; fax: +33 3 81665504.
*E-mail address:* jerome.husson@univ-fcomte.fr (J. Husson).

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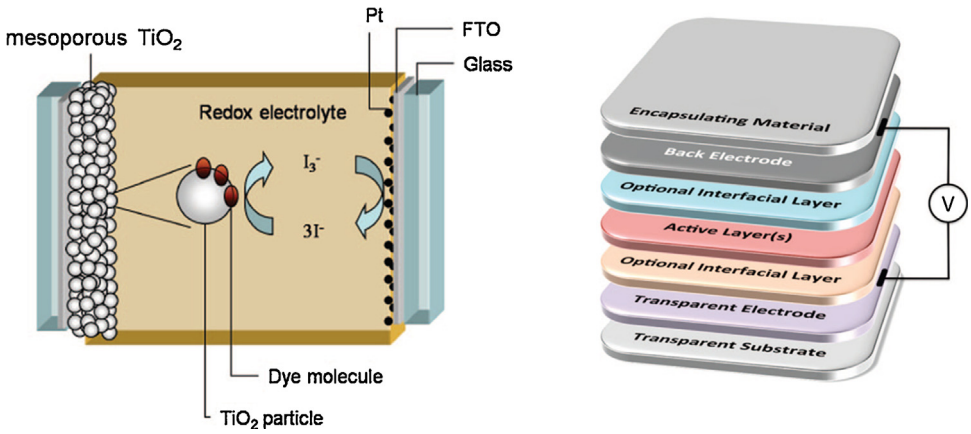


**Fig. 1.** Depiction of DSSC (left) and OSC, OPV devices (right) (reproduced with permission from references 5 and 10. © 2010 American Chemical Society).

## Preparation of furfuraldehyde from biomass

Many reviews are available dealing with the extraction of furfural from plants [13–15], to which the interested reader could refer. Nevertheless, it is important as a preamble to have a short discussion about this chemical. Furfural can be isolated from many renewable feedstocks [16] such as straw [17,18], corncobs [19,20], wood [21], olive stones [22,23], palm trees [24], cottonseed [25], rice [26] and hulls or stalks from different plants [27] amongst others. All these raw materials contain polymeric pentoses such as hemicellulose derivatives. Furfural is obtained through hydrolysis of the polymeric matter [28,29] to xylose. Dehydration and cyclisation of the latter affords furural **1** (Scheme 1).

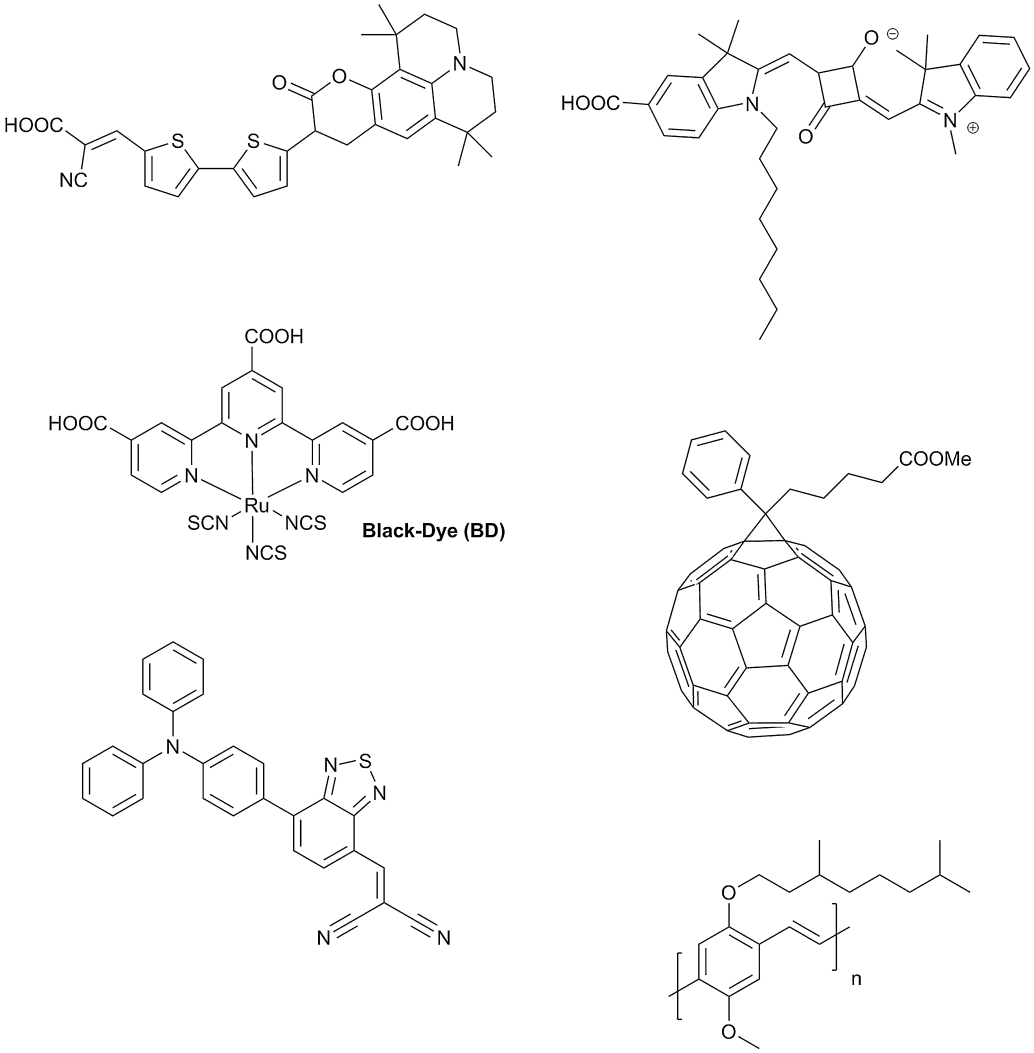


**Fig. 2.** Selected examples of molecules used in DSSC, OSC or OPV devices.