



# Photoelectrochemical characterization of electrodeposited ZnO thin films sensitized by octacarboxymetallophthalocyanine derivatives

Mopelola Idowu<sup>a,b</sup>, Thomas Loewenstein<sup>a</sup>, Andreas Hastall<sup>a</sup>, Tebello Nyokong<sup>b</sup> and Derck Schlettwein<sup>\*a</sup>

<sup>a</sup> Institute of Applied Physics, Justus-Liebig-University Giessen, Heinrich-Buff-Ring 16, D-35392 Giessen, Germany

<sup>b</sup> Department of Chemistry, Rhodes University, Grahamstown 6140, South Africa

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**ABSTRACT:** Hybrid thin films of crystalline zinc oxide (ZnO) modified by different octacarboxy-metallophthalocyanines (MOCPC) were prepared by the reabsorption method. Homogeneously blue or green thin films were formed. The photoelectrochemical characteristics of the electrodes were studied by time-resolved photocurrent measurements. Zinc(II) 2,3,9,10,16,17,23,24-octacarboxyphthalocyanine (ZnOCPC) showed considerably large quantum efficiency in sensitization of ZnO, one of the highest quantum efficiencies obtained so far with phthalocyanine-type sensitizers on nanocrystalline ZnO films.

**KEYWORDS:** zinc phthalocyanine, transient methods, electrodeposition, ionic, nanocrystalline.

## INTRODUCTION

In recent times, dye-sensitized solar cells (DSSCs) have received a great deal of attention as potential solar power devices since they are environmentally friendly and relatively cheap [1]. The sensitization of wide-bandgap oxide semiconductors such as TiO<sub>2</sub> and ZnO by organic dye molecules remains an attractive concept both for the high electron mobility and high photochemical stability of the oxide semiconductor and the high optical absorption of organic dyes [2–4]. Polymer foils or textiles have become of interest as substrates for DSSCs and ask for low temperatures throughout the processing of electrodes and cells. Deposition of materials from solutions without subsequent annealing represents a very attractive approach towards high-volume photovoltaics [5, 6]. Electrochemically induced crystallization of ZnO thin films in the presence of structure directing agents (SDA), e.g. eosin Y followed by desorption of the SDA after electrodeposition and

reabsorption of a chosen sensitizer molecule from solution, have been found to produce films with high roughness factors which make the sensitizer molecules, like metallophthalocyanines, easily accessible in the ZnO pores [7–10].

Metallophthalocyanines (MPCs), a family of aromatic macrocycles based on an extensive delocalized 18 $\pi$  electron system, are an important group of porphyrin-like compounds. They are attractive as chromophores for light-driven processes such as photoredox reactions in solutions, photodynamic therapy of cancer, photoelectrochemical reactions and as photovoltaic cells [11–14] due to their known exceptional stability, intense absorption in the red and near infra-red regions of the solar spectrum, non-toxicity, and ease of oxidation and reduction [15]. MPCs are particularly interesting since groups such as sulfonic or carboxylic groups as substituents on their rings render them water-soluble [16–19]. These groups are also very important in their application as sensitizers in DSSCs, since proper chemical binding to the semiconductor oxide surface requires the dye molecules to carry acid functionalities to allow for formation of covalent bonds to the hydroxide groups on the surface of the growing oxide [20].

<sup>†</sup>SPP full member in good standing

\*Correspondence to: Derck Schlettwein, email: [schlettwein@uni-giessen.de](mailto:schlettwein@uni-giessen.de), tel: +49 641-993-3400, fax: +49 641-993-3409