Curcumin-Ru Complex for Dye-Sensitized Photoelectrochemical Water Splitting

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Introduction

The recent adverse changes in global climate and depleting energy resources have pushed researchers in quest of various environmentally benign energy recourses. Tapping the solar energy for electrical facilities has been one of the most lucrative forms of resources to-date. Solar energy offers a desirable alternative to the existing oil based technologies due to its inherently decentralized and inexhaustible character. However, several important goals need to be met to fully utilize solar energy for the global energy demand. PEC water splitting using dye sensitized electrodes is a new area of research with significant potential for the development of high performance solar fuel systems [1]. However, the current performances of these systems are very poor. The quantum yields range between 2-3% of visible light. Further, the chemical attachment of the dye to the high surface area TiO_2 is an important and subtle issue. Information and dyes addressing the adhesion aspect are not addressed significantly. Though sporadic information on high performing Ru-free sensitizers is available, the use of curucumin dye as a photoanode for water splitting is not available to the best of the knowledge of the authors.

In the present work we report the synthesis and application of a ruthenium-curcumin ($Ru(dcbp)_2$-Curcumin) complex in water splitting. Further, we have shown that it improves the anchoring between the dye and the electrode enabling efficient electron transfer.

Experimental

The dye shown in Figure 1 was synthesized by an elaborate synthesis procedure starting from complexation reaction between curcumin and $Ru(dcbp)_2Cl_2$. Titanium nanotubes prepared by anodization process were sensitized using the synthesized dye and were used as the photo anode. The photocurrent measurements were carried out in a typical three electrode system under AM1.5G – 1Sun condition in an acidic medium (0.1M H_2SO_4).

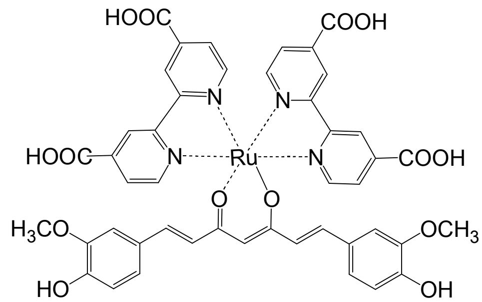

Figure 1. Structure of the synthesized dye

Results and Discussions

The structure of the synthesized $Ru(dcbp)_2$-Curcumin was confirmed using ^{1}H NMR. The UV-vis absorption showed typical MLCT absorption peak at 554 nm for the curcumin-Ru complex. In addition, the HOMO and LUMO energy levels were calculated using Gaussian 09W. The synthesized dye was studied for its photoelectrochemical water splitting properties and was compared in dark. The dye showed significant improvement in the photocurrent under visible light. Further, the electrochemical impedance spectroscopy under light showed a reduce charge transfer resistance compared to that under dark. These studies highlight the visible light photoresponse of $Ru(dcbp)_2$-Curcumin and its effect on the photoelectrochemical water splitting. These results should provide a good insight into the use of natural dyes for visible light PEC.

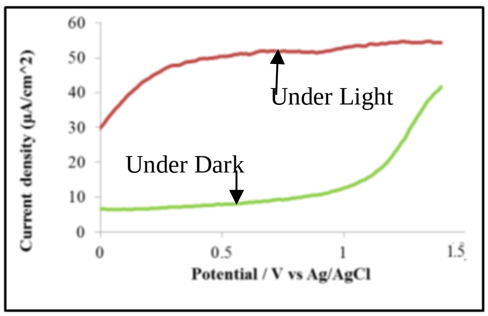

Figure 2. Photocurrent-voltage curves of the dye sensitized anodes in dark and under light

Reference

[1] J-H Kim, K-S Ahn, Jap. J. Appl. Phys. 49 (2010)