GERMANY/HONG KONG JOINT RESEARCH SCHEME
THE PROJECT REPORT
(for Project Completion)

Project Number: G_HK020/11

Title

Phosphorescent Metallopolymers and their Applications in Energy Conversion

Particulars

	Hong Kong team	German team
Name of Project Co-ordinator (with title)	Prof. Wong, Wai-yeung, Raymond	Prof. Ulrich S. Schubert
Name of Co-Investigator (if any)		
Institution or Institutional affiliation	[ ] CityU [ ] HKU [ ] CUHK [ ] HKUST [√] HKBU [ ] LU [ ] HKIEd [ ] PolyU	[√] Laboratory of Organic and Macromolecular Chemistry (IOMC), Friedrich-Schiller-University Jena, Germany [ ] Others: _____
Other project team members (if any)		

Funding Period

	1st year	2nd year (if applicable)
Start Date	1 Jan 2012	1 Jan 2013
Completion Date	31 Dec 2012	31 Dec 2013

Objective(s) as per original application

1. Development of synthetic routes to a new series of phosphorescent metallopolymers with heavy transition metals such as iridium(III) and platinum(II);
2. Systematic correlation of the observed functional properties of these metallopolymers to the nature of the conjugated organic linkers and metal centers present and their structural aspects;
3. Study of the applications of these triplet-forming materials in light-emitting devices and solar cells.

Details of Report [Please attach relevant document(s)]

i) Outline of proposed research and results obtained

This cooperation program aims at exploring and studying the functional properties of new phosphorescent metallopolymers and their potential applications through the synergism of physical measurements, computational studies and molecular device fabrication using international collaborative activities. We plan to pursue detailed investigations of these novel organometallic conjugated polymers in order to better understand their action in various optoelectronic applications including organic light-emitting diodes (OLEDs) and organic solar cells.

The proposed research is fruitful. We have completed the objectives in general and two joint papers have been published in SCI journals. There is a good exchange of knowledge by staff from the two teams in Hong Kong and Germany in the past two years.

ii) Significance of research results

The variation of the central chromophore in *bis*terpyridine Zn^{II} coordination polymers allowed the assembly of blue-, green- and red-emitting materials. The dynamic nature of the Zn^{II} complex enabled the systematic assembly of a library of statistical copolymers in an efficient way by simply mixing the respective homopolymer solutions. Depending on the used ratios and consequent energy transfer processes, the resulting emission colors can be tailored. The kinetic lability of the Zn^{II} *bis*terpyridine polymers was, moreover, utilized to assemble thin films of statistical copolymers in a simple and material-saving manner by inkjet printing. For that reason, the pure color inks were printed separately on top of each other, followed by one solvent layer to enable the assembly of statistical copolymers. The emission spectra of the resulting films are bathochromically shifted due to aggregation of the chromophores. The obtained data allowed estimating the CIE coordinates of the emission color for most ratios of the three polymers used and thereby produced tailor-made emission color.

Introducing well-defined polymeric side chains to *bis*terpyridine coordination polymers enables the synthesis of materials with tailor-made optical and mechanical properties. The polymers are introduced either by a copper-catalyzed azide-alkyne cycloaddition (*grafting-onto*) or an atom-transfer radical polymerization (*polymerization-from)* method. The resulting metallopolymers exhibit improved solubility in common organic solvents and could, therefore, be inkjet-printed from chlorinated benzene solutions. The photophysical properties of the so-produced homogeneous films have been investigated and a proof-of-principle polymer light-emitting device could be constructed.

iii) Research output

(1) A. Wild, A. Teichler, C.-L. Ho, X.-Z. Wang, H. Zhan, F. Schlütter, A. Winter, M.D. Hager, W.-Y Wong* and U. S. Schubert*, "Formation of Dynamic Metallo-copolymers by Inkjet Printing: Towards White-Emitting Materials", *J. Mater. Chem. C*, **2013**, *1*, 1812-1822.

(2) A. Wild, A. Teichler, C. Won der Ehe, A. Winter, M. D. Hager, B. Yao, B. Zhang, Z. Xie, W.-Y. Wong* and U. S. Schubert*, „ZnII Bisterpyridine Metallopolymers: Improved Processability by the Introduction of Polymeric Side Chains", *Macromol. Chem. Phys.*, **2013**, *214*, 1072-1080.

Potential for or impact on further research collaboration

This project generates great potential for future research collaboration. We are still collaborating on some projects on phosphorescent metallopolymers based on iridium-containing complexes and some preliminary results have been obtained. On the other hand, collaborative work has started on a project for organic battery. We have also initiated a plan to apply for other joint research funding in Germany in the near future.