

PGMs IN THE LAB

New Ruthenium Complexes for Dehydrogenation Reactions

Johnson Matthey and Alfa Aesar support new platinum group metals research

Johnson Matthey and Alfa Aesar, a Johnson Matthey Company, support a variety of research into new applications of the platinum group metals. Here we profile one of the researchers whose work has benefited from this support. Robert Wolf is a Professor of Inorganic Chemistry at the University of Regensburg, Germany, and his work revolves around the discovery of new, reactive transition metal compounds and the development of new applications for these compounds in synthesis and catalysis.

About the Research

Ruthenium complexes with *N*-heterocyclic carbene (NHC) ligands are of much interest in homogeneous catalysis. We synthesised unusual cationic tetrakis-carbene complex $[\text{RuH}(\text{IME})_4][\text{BEt}_4]$ (**1**, **Figure 1**), which features an NHC ligand (IME) that displays four methyl substituents. This complex has a square pyramidal structure with a vacant coordination site that may be exploited advantageously for the coordination of molecules such as H_2 . Using the *iso*-propyl-substituted ligand IPr we isolated the complex $[\text{RuCl}(\text{IPr}')(\text{PCy}_3)_2]$ (**2**, **Figure 1**), which is formed *via* the unusual activation of three *iso*-propyl C–H bonds. We are currently investigating the potential of these and related complexes as catalysts for dehydrogenation reactions. Another important aspect is the ability of complex **1** and related compounds to activate small molecules such as H_2 , CO_2 and P_4 .

About the Researcher



Professor Robert Wolf

- * Name: Robert Wolf
- * Position: Professor of Inorganic Chemistry
- * Department: Institute of Inorganic Chemistry
- * University: University of Regensburg
- * Street: Universitaetsstr. 31
- * City: Regensburg
- * County: Bavaria
- * Post or Zip Code: 93047
- * Country: Germany
- * Email Address: robert.wolf@ur.de
- * Website: <http://www.uni-regensburg.de/chemistry-pharmacy/inorganic-chemistry-wolf/index.html>

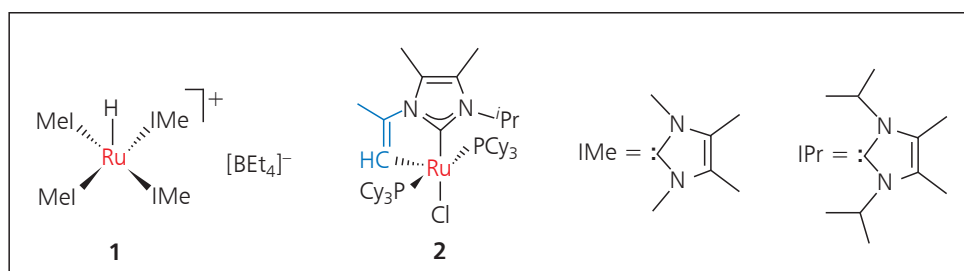


Fig. 1.
New NHC
ruthenium
complexes

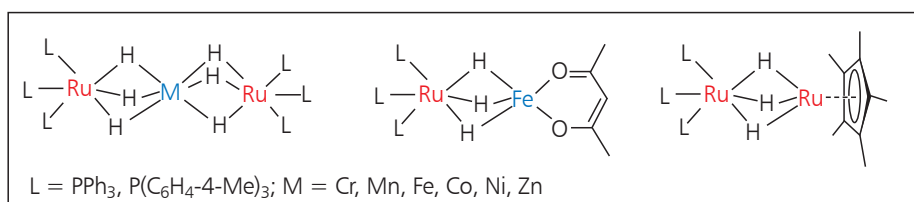


Fig. 2. Examples of new phosphane-stabilised polyhydrido-ruthenium complexes from Wolf's group

Polynuclear hydridoruthenium complexes show the remarkable ability to activate unreactive substrates in a cooperative fashion whereby two or more metal atoms participate. Literature examples include cyclopentadienyl-substituted complexes that effect very unusual, multiple C–H and C–C bond activations. Despite such spectacular examples, suitable, reactive polyhydrides are still very scarce, however. In this project, we investigate novel polynuclear polyhydrides of ruthenium that can be utilised for the cooperative activation of unreactive bonds and in homogeneous catalysis. **Figure 2** shows a range of complexes we have recently prepared. We are currently investigating the reaction chemistry and catalytic applications of these complexes. Some of them display unusual spectroscopic and magnetic properties, such as a high-spin ground state for the 3d metal ion in the paramagnetic complexes with M = Cr–Ni. Furthermore, we are

currently extending our studies to other electron-rich transition metals such as rhodium and iridium.

Recent Publications

- M. Plois, W. Hujo, S. Grimme, C. Schwickert, E. Bill, B. de Bruin, R. Pöttgen and R. Wolf, *Angew. Chem. Int. Ed.*, 2013, **52**, (4), 1314
- M. Plois, T. Wiegand and R. Wolf, *Organometallics*, 2012, **31**, (24), 8469
- E.-M. Schnöckelborg, M. M. Khusniyarov, B. de Bruin, F. Hartl, T. Langer, M. Eul, S. Schulz, R. Pöttgen and R. Wolf, *Inorg. Chem.*, 2012, **51**, (12), 6719
- E.-M. Schnöckelborg, J. J. Weigand and R. Wolf, *Angew. Chem.*, 2011, **123**, (29), 6786
- R. Wolf, M. Plois and A. Hepp, *Eur. J. Inorg. Chem.*, 2010, (6), 918
- R. Wolf and M. Plois, *Eur. J. Inorg. Chem.*, 2010, (28), 4419