

## PGMs IN THE LAB

# New Diphosphines for Molecular and Nanoparticle Catalysis

Johnson Matthey and Alfa Aesar support new laboratory research

Here another researcher whose work has benefited from the support of Johnson Matthey and Alfa Aesar, A Johnson Matthey company, is profiled. Piet van Leeuwen is a Professor and Group Leader at the Institute of Chemical Research of Catalonia (ICIQ), Spain. His interest ranges from fundamental aspects to applied catalysis utilising mainly late transition metals.

## About the Research

The main research interest of the group is the development of new and more efficient catalytic systems *via* a thorough study of ligand effects in homogeneous and nanoparticle catalysis with metals such as ruthenium, rhodium, palladium and platinum. Their research strategy is based on ligand design and a combination of classic synthetic methodologies and modern combinatorial and supramolecular approaches for fast generation of diverse catalytic entities. For instance, diphosphine based chiral assemblies containing simple chiral diols as modifiers are easily formed (**Scheme 1**). The corresponding chiral assemblies are used as ligands to form versatile asymmetric hydrogenation catalysts based on rhodium or iridium (**Figure 1**).

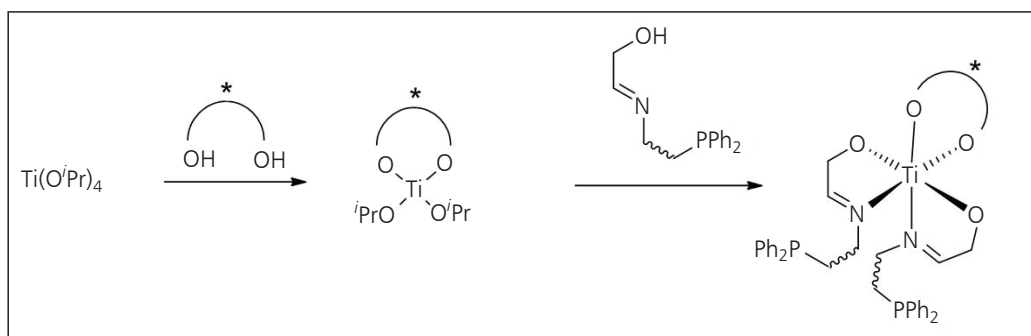
In metal nanoparticle catalysis the group's aim is the introduction of control over the nanoparticle formation with the aid of ligands, similar to that of

## About the Researcher



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Scheme 1. Diphosphine chiral ligand assembly synthesis

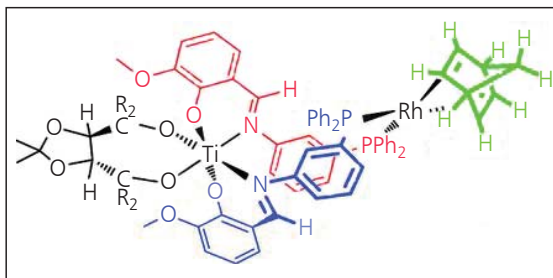


Fig. 1. Rhodium complexes for asymmetric hydrogenation (Reproduced from P. W. N. M. van Leeuwen, D. Rivillo, M. Raynal and Z. Freixa, *J. Am. Chem. Soc.*, 2011, 133, (46), 18562)

homogeneous systems, while the catalytic reactions being studied are typical of heterogeneous catalysts. Ruthenium nanoparticles (RuNPs) stabilised by phosphorus containing ligands (diphosphines and secondary phosphine oxides) and *N*-heterocyclic carbenes (NHC) were synthesised and used successfully for hydrogenation of aromatic derivatives. RuNPs stabilised by benzofurobenzofuran diphosphine **1** are highly active for hydrogenation of aromatics at room temperature. In **Figure 2**, a model of the complex  $Ru_{55}(\mathbf{1})_4$  shows how benzene could easily and nicely fit at the RuNPs surface, explaining their high catalytic activity and productivity for aromatic derivative hydrogenation.

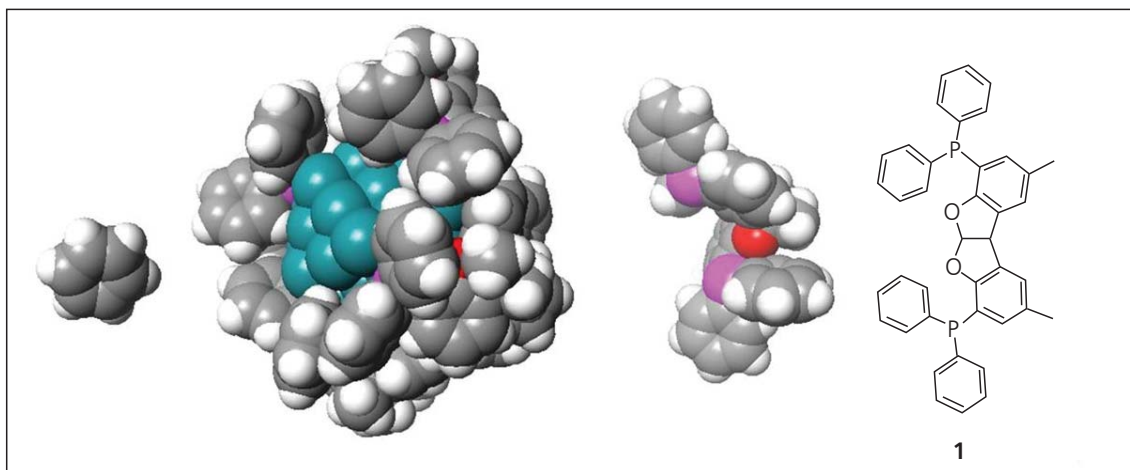


Fig. 2. A model of  $Ru_{55}(\mathbf{1})_4$  cluster (centre); diphosphine **1** and a benzene molecule (left)

Currently, the group is extending their work on metal nanoparticle synthesis to gold, rhodium and platinum with applications in (enantio)-selective hydrogenation among other reactions, as well as designing new ligand systems for nanoparticle stabilisation.

#### Acknowledgements

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#### Recent Publications

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