Organometallic Chemistry and Catalysis

The Mountford Group is an international mixture of postdoctoral researchers, PhD and Oxford Masters (Part II) students, and visiting academic fellows. We are working on the synthesis and stoichiometric and catalytic chemistry of organometallic compounds of the transition and lanthanide metals. Please browse the outline information below and then visit the Mountford Group web site for full details, including the latest news from the group, who we are and what we do, along with details of how to join the group. Selected references are given in the next section. Click here for a printable version of this site.

Synthesis, bonding and small molecule activation reactions of transition metal hydrazide complexes

Transition metal hydrazides, $(\mathcal{L})M=NNR_2$, have been of continuing interest because of their relevance to the biological conversion of $N_2$ to ammonia. Much of the early work was based around Group 6 systems for which $M=N-NR_2$ group small molecule reactivity is minimal. Group 4 hydrazides have significantly more activated $M=NNR_2$ functional groups. There has recently been a surge in activity in this area with a wide range of hitherto unprecedented new small molecule reactivity. We have been at the forefront of this drive and one example of our new titanium hydrazide chemistry is shown above.

New ring opening polymerisation catalysts for biodegradable and biocompatible green polymers as substitutes for oil-derived materials

There is a great deal of current interest in the controlled ring-opening polymerization (ROP) of cyclic esters such as e-caprolactone (CL) or lactide (LA) to form biocompatible or biodegradable materials. Lactide (see figure) is in principle infinitely renewable, being derived from corn and is thus a non-oil-derived, renewable resource. The key challenges are the controlled ROP of these cyclic esters allowing control of polymer molecular weight, tacticity.
We have been developing three new families of organometallic compounds for the ROP of cyclic esters using either metal-borohydride catalysts (illustrated above), sulfonamide-supported catalysts or amine-co-initiated cationic or zwitterionic catalysts. Further details

**Synthesis, structure, bonding and reactivity of unusual organometallic complexes**

In addition to the three themes summarised above we continue to be interested in fundamental aspects of organometallic synthesis, bonding and reactivity from a "blue skies" exploratory point of view. Recent examples of this type of chemistry are illustrated below. Further details

The first Group 3 and lanthanide boryl (metal-boron single bond) compounds

The first calcium-transition metal bond and a comparison with a lanthanide-transition metal counterpart

**Fundamental and applied studies of new olefin polymerisation and oligomerisation catalysts**

Ziegler-Natta alkene polymerisation catalysis is a very important current area of organometallic chemistry. Inspired by the early successes of Group 4 metalocene catalysts Cp₂MX₂ (X = alkyl or halide), a huge amount of academic and industrial effort is being spent world-wide on developing new transition metal catalysts that combine very high activities with good control of polymer molecular weight, as well as also understanding the underlying fundamental chemistry.

The catalytically active species in this chemistry are alkyl cations [(L)M-R]⁺. In a joint venture between our group, industrial sponsors in the field of catalysis and the UK research councils we

http://research.chem.ox.ac.uk/philip-mountford.aspx
are developing new families of new “post-metallocene” catalysts; a recent example is shown above. Further details

Selected Publications

Here are some selected recent publications, including graphical summaries. For a complete publication list click here. Details of our collaborations and funding are given at the end. Click here for a printable version of this site.

Synthesis and small molecule activation reactions of transition metal hydrazide complexes


Cycloaddition reactions of transition metal hydrazides with alkynes and heteroalkynes: coupling of Ti=N=NPh₂ with PhCCMe, PCCH, MeCN and 1BuCP. J. D. Selby, A. D. Schwarz, C. Schulten, E. Clot, C. Jones and P. Mountford, Chem. Commun., 2008, 5101-5103. Designated a "hot article" by the Editor. [link to journal].

Synthesis and polymerisation studies of new catalysts for the preparation of biodegradable and biocompatible polymers


Fundamental and applied studies of new olefin polymerisation and oligomerisation catalysts


"Imido titanium compounds bearing the 6-dimethylamino-1,4,6-trimethyl-1,4-diazacyclocloheptane ligand: synthesis, structures, solution dynamics and ethylene polymerisation capability". G. J. Hayday, C. Wang, N. H. Rees and P. Mountford, Dalton

Fundamental aspects of the synthesis, structure, bonding and reactivity of unusual organometallic complexes


Collaborations and Funding

Here are some details of our current principal collaborations and funding

Prof Simon Aldridge (Oxford) and Prof Cameron Jones (Monash University, Australia). Transition and main group boryl and gallyl chemistry.

Dr Eric Clot (University of Montpellier, France) and Prof. Nik Kaltsoyannis (University College London). Computational studies of mechanism and electronic structure.

Prof Charlotte Williams (Imperial College London, UK). Ring-opening polymerisation catalysis).

Profs Glen Deacon and Peter Junk (Monash University, Australia). Lanthanide and Group 2 phenolate complexes for the living and immortal ring-opening polymerisation of cyclic esters.

Our work has been funded by grants from the EPSRC, Leverhulme Trust, Nuffield Foundation, China Scholarship Council, EC (Marie Curie), University of Oxford, British Council, Royal Society and the Royal Society of Chemistry. Applied aspects of our research have been supported by DSM Research, DSM Elastomers, Sabic Europe, Cambridge Material Science and Millennium Pharmaceuticals.