



Apeiron's olefin metathesis catalysts

Apeiron's catalyst offerings

The Apeiron Advantage

Apeiron Synthesis has developed a growing portfolio of over twenty exceptional metathesis catalysts designed to accommodate a wide range of applications, with catalyst availability from gram to multi-kilogram quantities, suitable for applications in R&D as well as in large scale production.

Our technology platform offers customers:

- Broad and growing portfolio of catalysts with applications to all metathesis reaction types
- Catalysts optimized for continuous flow - with high turnover and extended reusability
- High efficiency catalysts for metathesis in water, at room temperature and on solid support
- Extensive metathesis centered know-how, unique tools and process chemistry expertise that combine to meet challenging chemistry objectives
- A variety systems of catalyst-activator and catalyst-retardant applicable in metathesis polymerization reactions

Apeiron Synthesis is dedicated to providing products and services that transform our customers' chemistry to save time and money with cost effective, efficient, sustainable processes.

How does it work?

Our technology platform is highly modular, enabling us to manufacture catalysts incorporating process-specific structural modifications in the labile (ionic and benzylidene) and non-labile (NHC and CAAC) ligands. Apeiron takes advantage of proprietary technology that is the result of our in-house research program as well as intellectual property licensed from leading European industrial and academic partners.

We specialize in modifications of the NHC and CAAC ligand to append customized utility tags - affording novel catalyst traits for process-specific requirements, such as altered solubility profiles, simpler post-reaction work-up or easier removal of ruthenium residues from products.

Validation by Industry

Apeiron catalysts have been extensively tested and some have also become industry standards. When compared to other options, our catalysts have demonstrated clear superiority with respect to reaction time, temperature, dilution factor, reactivity and selectivity.

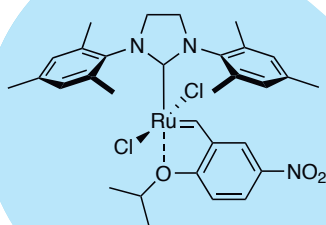
Nitro-Grela Catalyst Group

Core Catalyst: nitro-Grela

AS2032

CAS: 502964-52-5

PCT/EP2003/011222

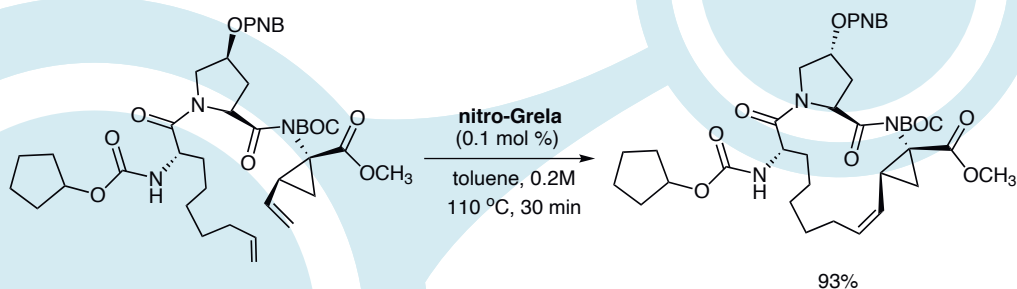


Group characteristics and application:

- Has proven efficiency in macrocyclization
- High initiation rate, even below room temperatures
- Excellent selectivity

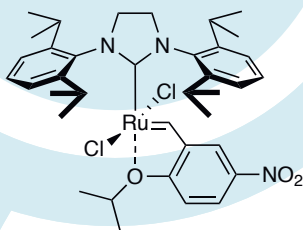
References:

V. Farina, C. Shu, X. Zeng, X. Wei, Z. Han, N. K. Yee, C. H. Senanayake; Second-Generation Process for the HCV Protease Inhibitor BILN 2061: A Greener Approach to Ru-Catalyzed Ring-Closing Metathesis; *Organic Process Research & Development*, 13, 250–254 (2009)

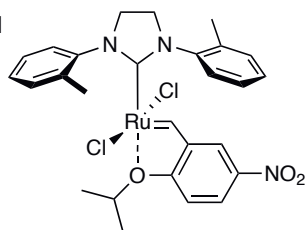


Other catalysts in this group:

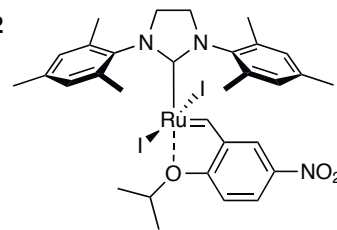
AS2033



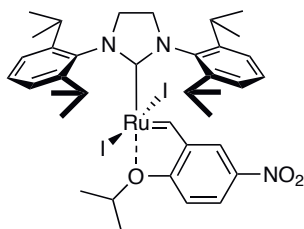
AS2051



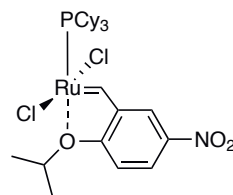
AS2052



AS2053



AS2080



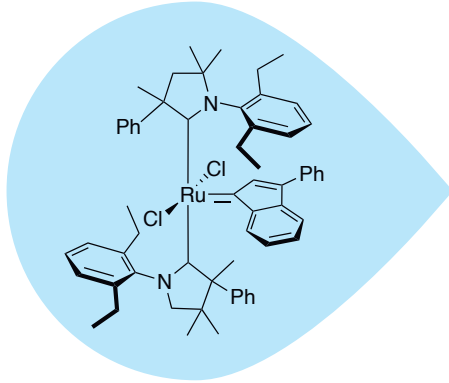
Bis-CAAC catalyst group

Core Catalyst: UltraCat

AS2086

CAS: 2055540-61-7

PCT/IB2016/054486

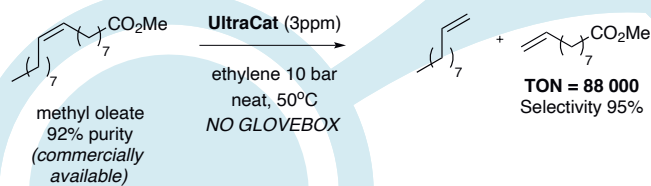


Group characteristics and application:

- High stability
- Excellent for CM of terminal olefins, ethenolysis
- Very good for mRCM and RCM leading to small/medium rings

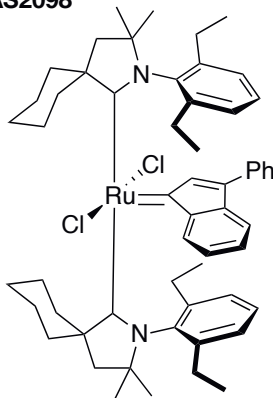
References:

R. Gawin, A. Kozakiewicz, P. A. Guńka, P. Dąbrowski, K. Skowerski, „Bis(Cyclic Alkyl Amino Carbene) Ruthenium Complexes: A Versatile, Highly Efficient Tool for Olefin Metathesis”, *Angew. Chem. Int. Ed.*, 56, 910, (2017)



Other catalysts in this group:

Ultra LatMet
AS2098



Group characteristics and application:

- Excellent for ring opening metathesis polymerization of highly reactive monomers
- Highly tunable activity with co-catalysts and additives for specific polymerization process requirement
- Long shelf life of ready-to-use formulations
- Compatible with wider range of fibers and mineral fillers

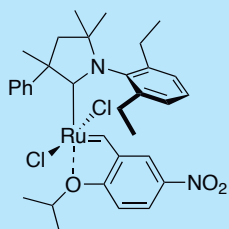
Nitro-CAAC catalyst group

Core Catalyst: UltraNitroCat

AS2091

CAS: 2106819-64-9

PCT/IB2016/054486

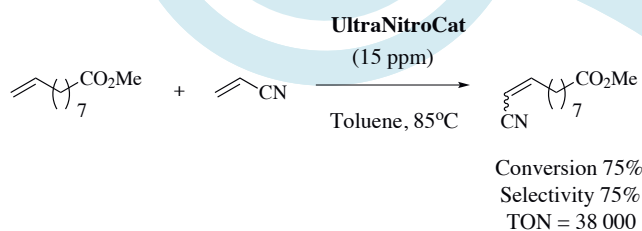


Group characteristics and application:

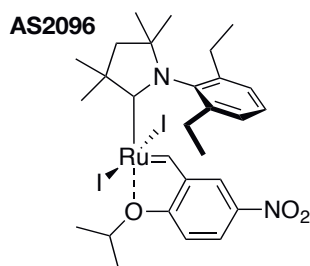
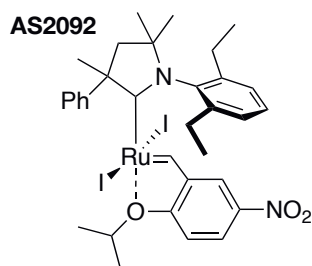
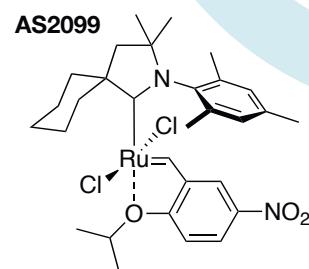
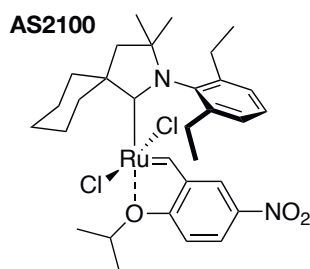
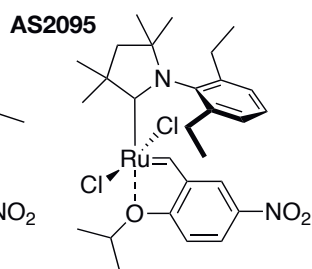
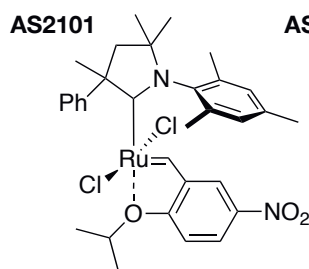
- High stability
- Excellent for macrocyclic RCM
- Excellent for CM with nitriles
- Very good in CM of terminal olefins

References:

R. Gawin, A. Tracz, M. Chwalba, A. Kozakiewicz, B. Trzaskowski, K. Skowerski, "Cyclic Alkyl Amino Ruthenium Complexes-Efficient Catalysts for Macrocyclization and Acrylonitrile Cross Metathesis", *ACS Catalysis*, 7 (8), 5443–5449 (2017).



Other catalysts in this group:



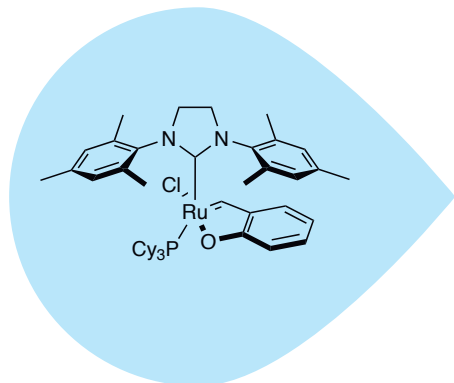
Latent Catalyst Group

Core Catalyst: LatMet

AS2035

CAS: 1407229-58-6

PCT/EP2013/065839

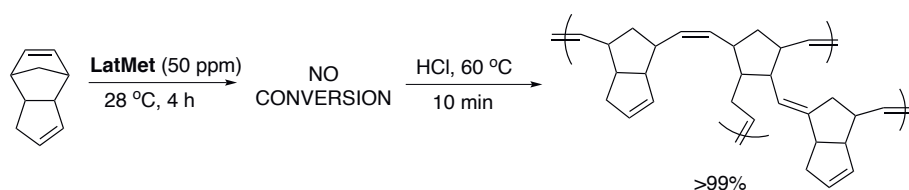


Group characteristics and application:

- Latent in the presence of reactive monomers
- High activity and efficiency after activation
- Chemical and/or thermal activation required

References:

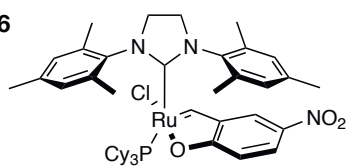
A. Kozłowska, M. Dranka, M. Zachara, E. Pump, C. Slugovc, K. Skowerski, K. Grela; Chelating Ruthenium Phenolate Complexes—Synthesis, General Catalytic Activity and Applications in Olefin Metathesis Polymerization; Chem. Eur. J., 20(43), 14120 – 14125 (2014)



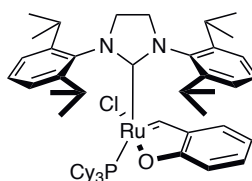
Other catalysts in this group:

Chemically and thermally activated

AS2036

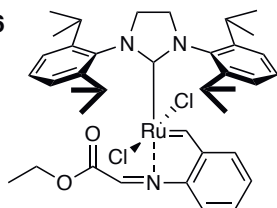


AS2037

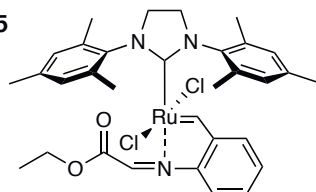


Thermally activated

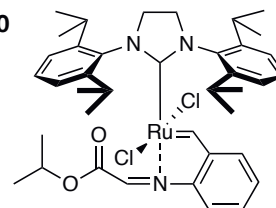
AS2056



AS2055



AS2070



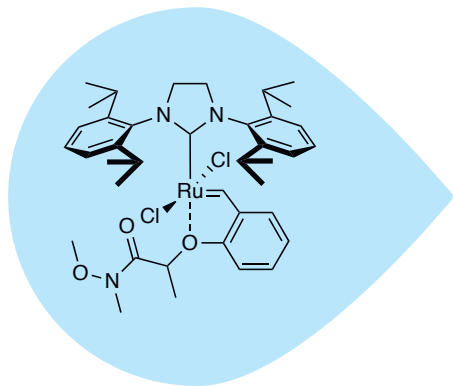
GreenCat Catalyst Group

Core Catalyst: GreenCat

AS2034

CAS: 1448663-06-6

PCT/EP2013/062435

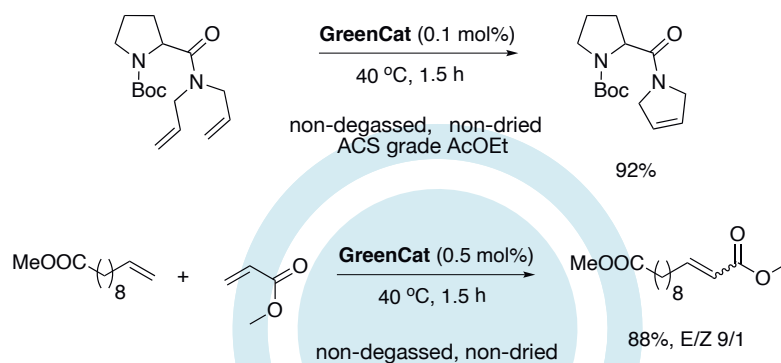


Group characteristics and application:

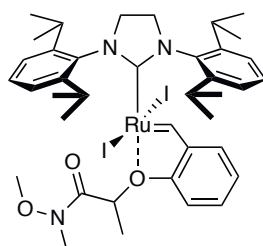
- Low residual ruthenium in the product after implementation of simple purification protocols
- Allows for catalyst recovery and reuse
- Excellent compatibility with ACS-grade green solvents (esters, ethers, hydrocarbons)

References:

K. Skowerski, P. Kasprzycki, M. Bieniek, T. K. Olszewski; Efficient, durable and reusable olefin metathesis catalysts with high affinity to silica gel; *Tetrahedron* 69, 7408 – 7415 (2013)



Other catalysts in this group:



AS2094

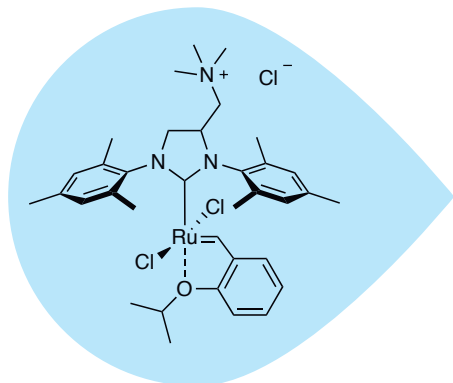
Ammonium-Tagged Catalyst Group

Core Catalyst: StickyCat Cl

AS2040

CAS: 1452227-72-3

PCT/EP2013/053967

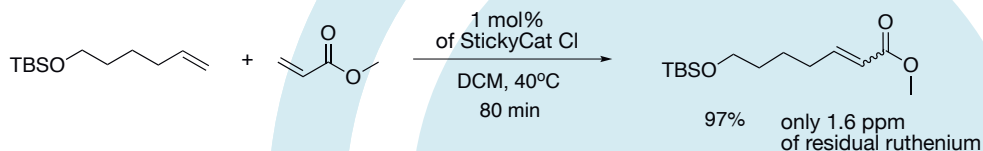


Group characteristics and application:

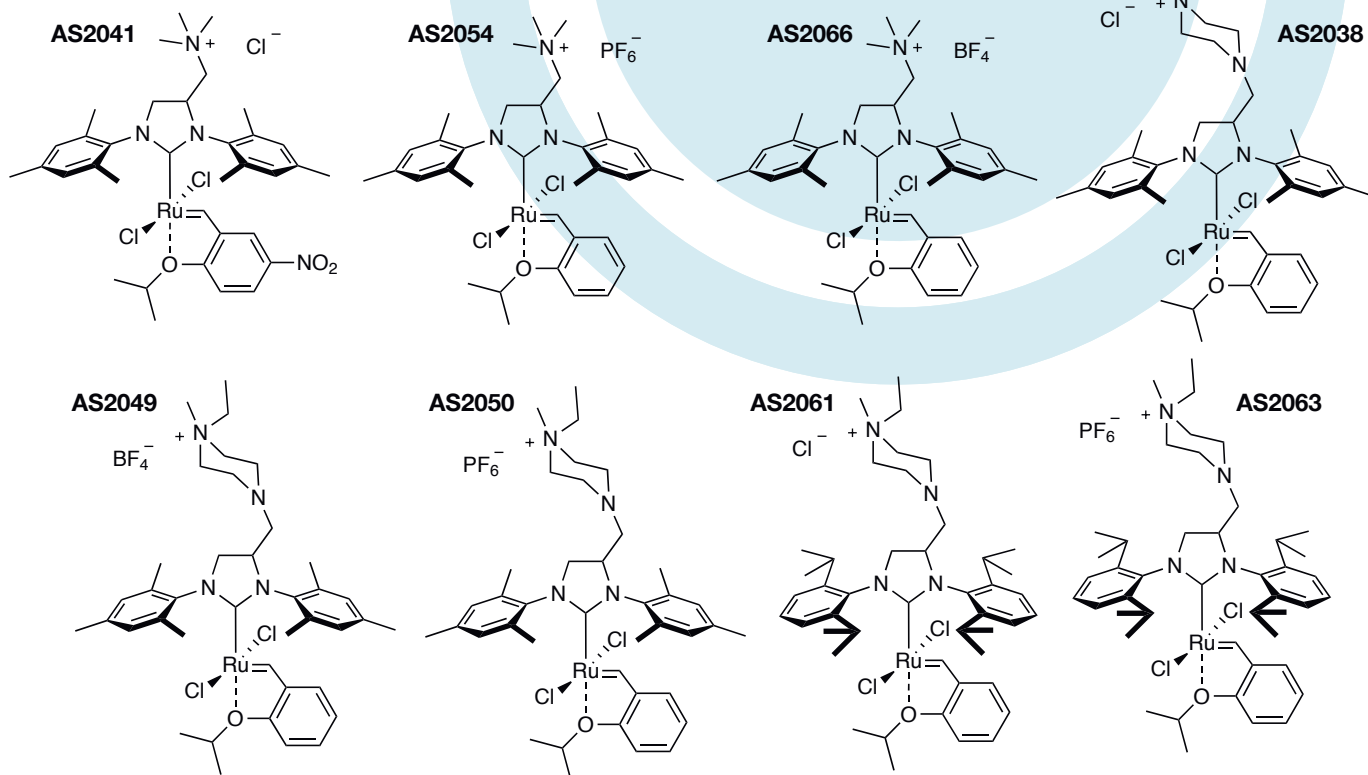
- Simple removal of residual ruthenium by extraction with water or work-up with silica gel
- Residual ruthenium < 5 ppm
- High activity in the temperature range of 40 – 110° C
- Designed to be deposited on solid support to increase reusability or for continuous flow applications
- Good solubility in neat water (up to 60 mg/ml)
- High stability in non-degassed water

References:

K. Skowerski, C. Wierzbicka, G. Szczepaniak, Ł. Gułajaski, M. Bieniek, K. Grela; Easily removable olefin metathesis catalysts; *Green Chem.*, 14(12), 3264 – 3268, (2012)



Other catalysts in this group:



Availability

All our **Core Catalysts** are available from STREM, TCI, Sigma Aldrich for R&D purposes.

Products available directly from Apeiron Synthesis: Extended Core Catalysts (Ammonium-Tagged Catalysts Group, GreenCat Catalysts Group, Latent Catalysts Group, nitro-Grela Catalysts Group and CAAC Catalysts Group) Heterogeneous Catalysts - provided on different solid support – on demand Process-Specific Catalysts - individually synthesized catalysts for both R&D and Process Chemistry with no restrictions on quantity

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