umicore
Precious Metals Chemistry

MERCK

Metathesis Application Guide

Grubbs Catalyst® Technology for Chemical Synthesis

2026 Edition

The Life Science Business of Merck operates as MilliporeSigma in the U.S. and Canada.

Sigma-Aldrich®
Lab & Production Materials

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Expertise in Metathesis Catalysts

Empowering Breakthrough Synthesis

We are committed to helping you reach new frontiers through an ever-expanding, always innovative portfolio of products. In line with this goal, we have partnered with Umicore PMC to bring you an outstanding range of olefin metathesis catalysts for chemical synthesis.

Our exclusive collaboration not only gives you direct access to Umicore's Grubbs Catalyst® technology, but also their development expertise. You'll enjoy rapid, reliable supply of milligram to multi-kilogram volumes, at the best value, with the Umicore license rights included. Discover an unparalleled portfolio of metathesis catalysts for your breakthrough synthesis ideas.

Umicore Precious Metals Chemistry

Umicore Precious Metals Chemistry (PMC) is part of the Umicore group, a global materials and technology company. With over 50 years of experience working with customers across the world, Umicore PMC has developed innovative metals and materials technology to help solve the most challenging chemistry problems. The company's extensive portfolio of chemical technologies includes the Grubbs metathesis, cross coupling and hydrogenation catalysts.

Umicore PMC operates in many key markets that are vital to developing solutions to real-world problems. This includes: pharmaceutical development, fine chemicals, automotive and electronics. Within these industries, the company offers many competitive technologies that deliver ground-breaking innovations. Taking a collaborative approach to its business, Umicore PMC works closely with customers in multiple aspects of R&D, process development and industrial manufacturing to create novel, cost-effective synthesis solutions.

The Best of Metathesis Catalysts

First established in the 1960s, alkene metathesis is considered the best method to synthesize long complex alkenes through the use of highly efficient and selective catalytic reactions. Employing a ruthenium metal complex, metathesis enables the simple synthesis of carbon-carbon double bonds. These reactions provide efficient routes to product synthesis by ensuring minimal waste due to the formation of less toxic by-products, high activity and high stereoselectivity.

Following decades of research and development in the field of metathesis, Umicore PMC provides a comprehensive portfolio of catalysts. In early 2018, the company expanded its offerings to include the world-class Grubbs Catalyst® intellectual property, following its acquisition of Materia's proprietary metathesis technologies. These catalysts, developed by Nobel Laureate Prof. Robert H. Grubbs and his team, deliver best-in-class performance, enabling robust alkene conversions.

Umicore PMC now offers secured access to the broadest catalyst portfolio for metathesis. This is in addition to the strong global operating and industrial scale manufacturing expertise that it has established over its decades of experience in the industry. The company's range of services are tailored to meet customer's specific metathesis needs. Umicore PMC experts can help support development processes; from scaling a reaction or devising new reaction routes, to screening the appropriate catalyst to maximize product formation.

About this Guide

Along with the experts at Umicore PMC, we have created this practical guide to help you apply olefin metathesis in your own synthetic routes. It starts by discussing general reaction parameters and practical considerations for running routine olefin metathesis reactions. It then covers some more challenging metathesis reactions with examples from academic, pharmaceutical, and specialty chemical laboratories, which illustrate some elegant solutions that have been developed. Finally, it provides a quick guide to selecting the appropriate metathesis catalyst for your specific synthesis.

Access an unparalleled portfolio of metathesis catalysts for your breakthrough synthesis: **SigmaAldrich.com/Grubbs**

Metathesis:
Key Features

Functional Group Tolerance

Modern active pharmaceutical ingredients are among the most complex molecules synthesized at commercial scale. Ruthenium-based metathesis catalysts succeed in forming key bonds in even the most challenging substrates, such as the macrocyclic peptide core of HCV NS3 protease inhibitors like ciluprevir, simeprevir, and related compounds used to treat hepatitis C infections.

Stereoselectivity

Recent advances in ruthenium-based metathesis catalysts offer opportunities for stereoselective metathesis reactions. In particular, Z-selective and stereoretentive catalysts offer new routes for chemists to control the E:Z ratio of newly formed alkenes. While this feature is potentially useful in almost any application, it is particularly advantageous to the production of insect pheromones, which must be prepared in the correct ratio of olefin isomers to be effective as natural deterrents for crops.

Activity and Catalyst Longevity

For chemical applications driven by aggressive cost targets, ruthenium-based metathesis catalysts have demonstrated unparalleled activity under rugged conditions. Renewable feedstocks such as soybean oil can be converted into specialty chemical products with turnover numbers in the hundreds of thousands. Thus, even in high-volume, low-margin products, metathesis can deliver significant cost advantages.

General Reaction Procedures

Metathesis reactions are versatile reactions that can be performed in most situations without the need for extensive optimization. However, for more difficult synthetic situations, Umicore PMC's team of industrial experts will tailor each reaction to the specific requirements for the project, ensuring precise and selective product formation. When devising any reaction, several factors need to be taken into account, including catalyst loadings, reaction conditions, and the desired functionality of the product.

Metathesis Reaction Types

There are three main classes of metathesis reactions, two of which are used regularly for small molecule organic synthesis. Ring-closing metathesis is an intramolecular reaction of an acyclic diene to form a ring (**Fig. 1**), while cross metathesis brings two olefins together in an intermolecular reaction to give an olefin product bearing substituents from each of the starting olefins (**Fig. 2**).

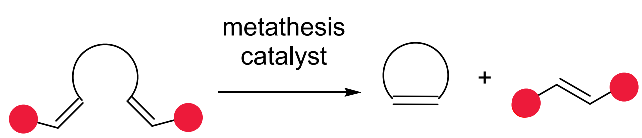


Figure 1. Ring-closing metathesis (RCM)

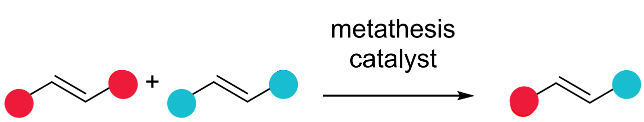


Figure 2. Cross metathesis (CM)

General Reaction Set-Up

1. Deoxygenated solvents and reaction mixtures are recommended for optimal results. If necessary, degas the solvent before use.
2. In a dry, inert reaction vessel with a stir bar, dissolve your substrate(s) in the solvent of choice.
3. Weighing the catalyst open to the air is fine. The reaction vessel should be pumped and purged with inert gas before dissolution of catalyst, whether the solid catalyst will be used directly or added as a solution. The use of degassed solvents is highly recommended, and the solvent should be degassed before it is added to the catalyst.
4. Heat the reaction to the desired temperature and monitor until complete.

Optimizing the Catalyst

For general metathesis reactions, Umicore Grubbs Catalyst® M202 and M204 as well as the Umicore Hoveyda- Grubbs Catalyst® M720 and M730 are recommended. Hoveyda-type catalysts initiate at room temperature and are highly stable, enabling simple storage and handling.
In metathesis reactions involving sterically hindered alkenes, it may be necessary to use a more specialized catalyst. For instance, Umicore Hoveyda-Grubbs Catalyst® M721, M730 or M731 can be used to perform sterically hindered ring rearrangement reactions owing to the decreased steric bulk of the protruding ligands.[1]

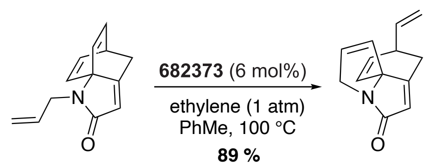


Figure 3. Metathesis of a sterically hindered substrate using Hoveyda-Grubbs Catalyst® M721

Alternatively, if the substituents on the substrate are bulky and consist of substituted alkenes, using the Umicore Hoveyda-Grubbs Catalyst® M722 could result in a higher yield.[2]

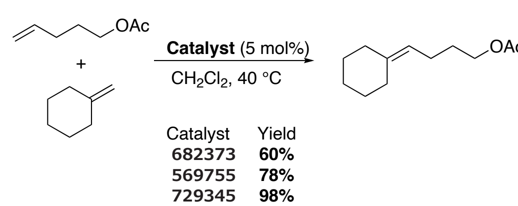


Figure 4. Reaction showing importance of correct catalyst selection

As long as reaction conditions are chosen carefully, high loadings of catalysts are not necessary. In some cases, using more catalysts may lead to unwanted side reactions. Even for challenging reactions, loadings less than 1 mol% can be effective given the careful choice of other reaction parameters. For assistance in choosing the right catalyst for RCM, Sigma-Aldrich offers a Kitalysis™ RCM screening kit for medium-sized (5, 6, 7) rings (product KITALYSIS-RCM).

Choosing the Right Conditions

Selecting the right operating conditions for your industrial reaction relies on careful optimization. Finding the right temperature is vital for catalyst initiation, with low temperatures being advantageous from an environmental perspective. Umicore catalysts typically initiate at low temperatures, between room temperature and 40 °C

Furthermore, the exact concentrations of reagents vary according to the specific metathesis reaction: cross metathesis requires concentrated solutions, macrocyclizations require dilute solutions, and other ring-closing metathesis reactions require intermediate concentrations.

Likewise, choosing the appropriate solvent to mediate metathesis reactions relies on understanding the various properties of the solvents. Preferred solvents include nonpolar, hydrocarbon-based solvents, chlorinated solvents and peroxide-resistant ethers, due to their weak binding affinity to the catalyst complex.

Preferred Solvents	Suitable in Certain Conditions	Not Recommended
Toluene, xylenes, mesitylene	MeOH, EtOH, nBuOH THF, ether	DMSO, DMF, NMP MeCN
Heptanes, hexanes DCM, DCE, chlorobenzene EtOAc, iPrOAc	Water (neutral/acidic)	Pyridine and other amines Water (basic)
TBME, Me-THF		

Finally, it is also vital to ensure that the catalytic reaction is devoid of catalyst poisons. Peroxides oxidize the metalcarbene bond, rendering the catalyst inactive. Ethene should also be removed as its presence could result in catalyst decomposition. In addition, all the Umicore Hoveyda-Grubbs Catalysts® are air and moisture stable as solids, but in solution are vulnerable to oxygen. Therefore, reactions need to be under an argon or nitrogen atmosphere to ensure the exclusion of oxygen.

Optimizing the Reaction Procedure

Beyond conditions, there are multiple aspects of the synthesis procedure that must be considered for successful completion of any reaction. Strongly coordinating functional groups must be masked to not disrupt the catalyst activity; the concentration of the various substrates must be optimized to prevent substrate polymerization but encourage the desired format of metathesis.[3]

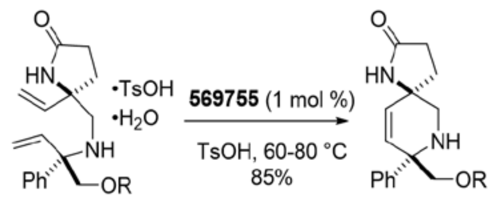


Figure 5. RCM using Hoveyda-Grubbs Catalyst® M720

Furthermore, to prevent unwanted side-effects of metathesis reactions, such as the isomerization of alkenes, it is sometimes necessary to use additives. For instance, mild acids such as acetic acid can be added to reaction to prevent hydride formation,[4, 5] as illustrated in the following reaction scheme:

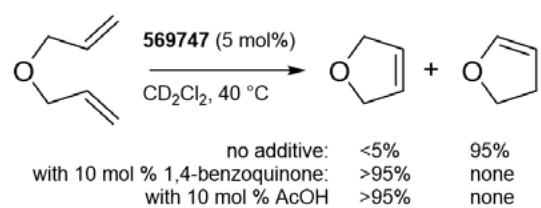


Figure 6. RCM using Grubbs® M204 showing the importance of additives

Metathesis reactions that bring together two terminal alkenes produce ethene as a by-product. Although ethene is a gas, it is soluble in organic solvents and can remain in the reaction mixture. Ensuring that ethene or any other gaseous by-product is efficiently removed will drive the reaction equilibrium toward completion. This can be accomplished by bubbling an inert gas through the reaction mixture over the course of the reaction. On scale, this technique is used frequently to help maximize catalyst lifetime.

Choose Your Metathesis Route

With many versatile reaction options available, selecting the right catalyst also relies on identifying the right metathesis reaction. Be it ring-closing metathesis, which can be used to synthesize complex polycyclic molecules, or cross metathesis, involving the intermolecular reaction of two unconnected alkenes, Umicore PMC offers hands-on expertise to discuss the best routes to your product, ensuring project success.

1. Ring-Closing Metathesis

Ring-closing metathesis is a common metathesis reaction for any scientist needing to synthesize mid- and macro-sized rings, as well as offering an efficient route to synthesize strained or sterically hindered rings. Proceeding via an intermolecular process, this reaction can be made almost irreversible following appropriate reaction optimization. The reaction is commonly used as a strategy in total synthesis for the construction of various ring sizes.

Mid-sized ring-closing metathesis

Preferred Catalysts	Optimal Catalyst Loading	Conditions
Umicore Grubbs Catalyst® M202 Umicore Grubbs Catalyst® M204 Umicore Hoveyda-Grubbs Catalyst® M720 Umicore Hoveyda-Grubbs Catalyst® M721 Umicore Hoveyda-Grubbs Catalyst® M730	3–10 mol%	Concentration: (depending on ring size) 1.0 M (5 membered ring); 0.5 M (6 membered ring) Temperature: 40–100 °C

Ring-closing metathesis to form an oxepane ring embedded in (-)-gambieric acid with applications in the pharmaceutical industry:[6]

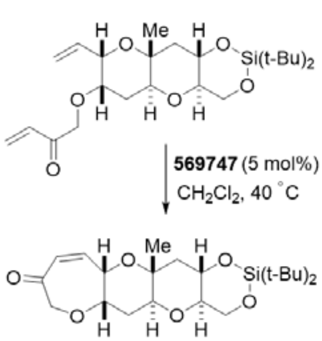


Figure 7. RCM to form oxepane ring embedded in (-)-gambieric acid using Grubbs® M204

Ring-closing metathesis to yield the synthesis of an 8-membered ring structure of serpendione:[7]

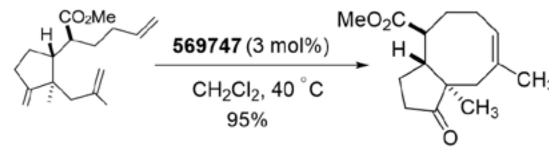


Figure 8. RCM for an 8-membered ring using Grubbs® M204

Ring-closing metathesis in the synthesis of (-)-stemoamide, a root extract used in Chinese and Japanese folk medicine:[8]

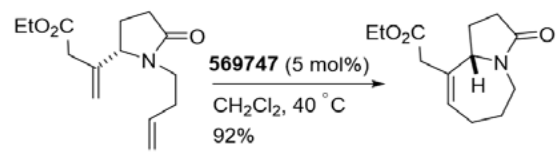


Figure 9. RCM for a 7-membered ring using Grubbs® M204

Grubbs M801 can facilitate the RCM of a range of diallyl substrates, as well as cross-metathesis, ROCM, and ROMP through electrochemical catalyst activation.[9]

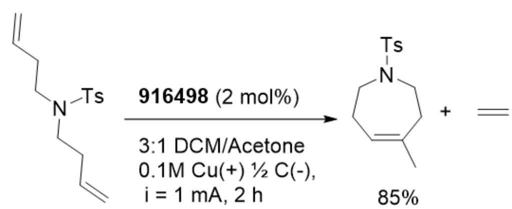


Figure 10. RCM using Grubbs® M800 of a 7-membered ring

Grubbs M800 has also been shown to be proficient in the RCM of diallyl malononitrile.[10]

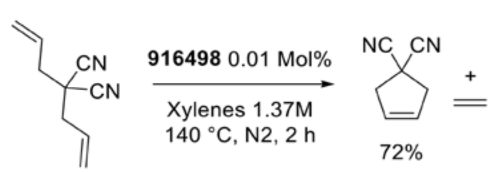


Figure 11. RCM using Grubbs® M800 of a 5-membered ring

Macrocyclic ring-closing metathesis

Preferred Catalysts	Optimal Catalyst Loading	Conditions
Umicore Grubbs Catalyst® M202 Umicore Grubbs Catalyst® M204 Umicore Hoveyda-Grubbs Catalyst® M720 Umicore Hoveyda-Grubbs Catalyst® M731	3–10 mol%	Concentration: (depending on ring size) 1.0 M (5 membered ring); 0.5 M (6 membered ring) Temperature: 40–100 °C

Ring-closing metathesis to form a 20-membered macrocycle used as a protease inhibitor in the pharmaceutical industry:[11]

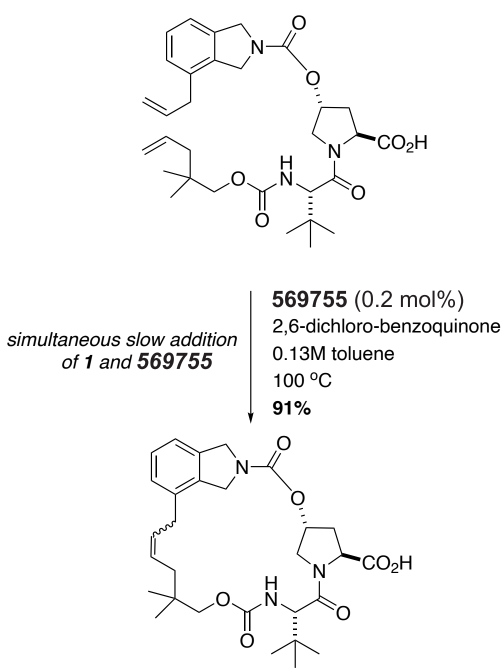


Figure 12. RCM using Grubbs® M720 for a macrocycle

Formation of a key intermediate in the preparation of the cytotoxic marine natural product (-)-spongidepsin:[12]

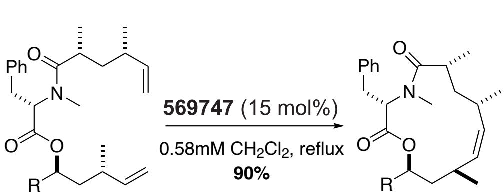


Figure 13. RCM using Grubbs® M204 for a macrocycle

Stewart–Grubbs catalyst enabled challenging ring-closing metathesis macrocyclization in a 25-step stereoselective total synthesis of iso-archazolids and archazologs, facilitating novel analog development with anticancer potential:[13]

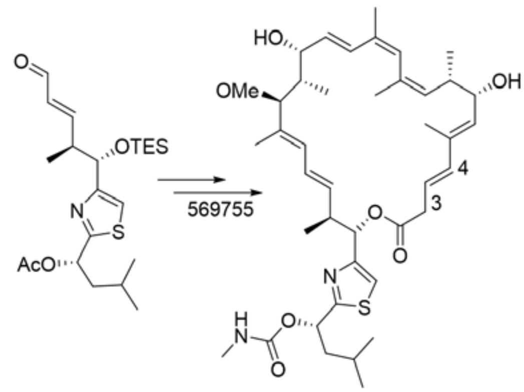
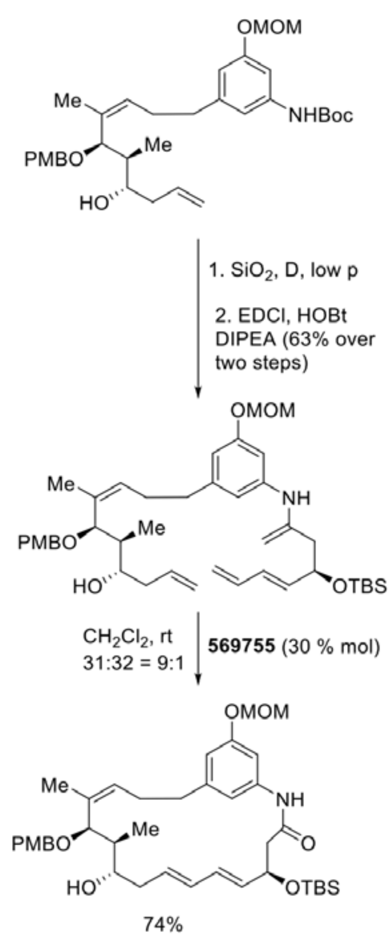


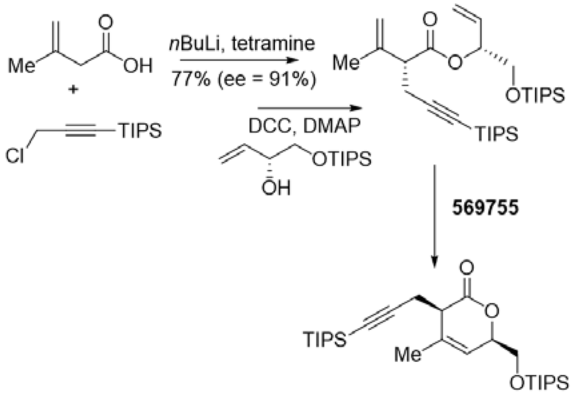
Figure 14. RCM using Grubbs® M720 for a macrocycle

Used for efficient diene-ene ring-closing metathesis, enabling macrocyclization in the first total synthesis of ansatrienol K alongside palladium cross-couplings and $Co_2(CO)_8$-catalyzed epoxide ring-opening:[14]



Scheme 1. RCM using Hoveyda-Grubbs® M720 for the synthesis of ansatrienol K

Hoveyda-Grubbs® M720 has been used in the total synthesis of (−)-haperforin G for an efficient ring-closing metathesis step enabling macrocyclic framework formation.[15]



Scheme 2. RCM using Hoveyda-Grubbs® M720 for the Synthesis of (−)-haperforin G

The first total synthesis of alcyonolide was accomplished in 13 steps using inverse electron demand hetero-Diels-Alder, zinc-mediated C–C bond formation, and Hoveyda-Grubbs® catalyzed olefin metathesis.[16]

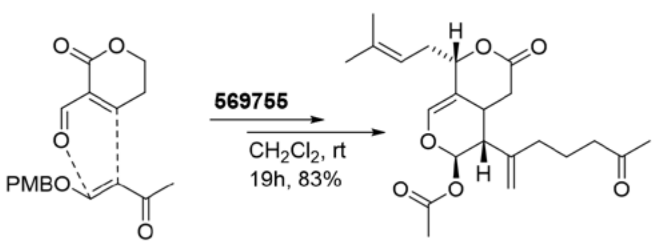


Figure 15. Synthesis of alcyonolide utilizing Hoveyda-Grubbs® M720

Hoveyda-Grubbs ® M720 has been used in the selective macro(mono)cyclization (MMC) of α,ω-dienes under continuous-flow spatial confinement immobilized in mesoporous silica, achieving up to 60% MMC selectivity:[17]

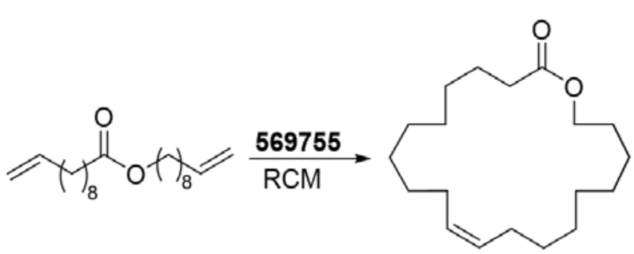


Figure 16. ROM using Hoveyda-Grubbs® M720 in the synthesis of a 20-membered heterocycle

Sterically demanding ring-closing metathesis

Preferred Catalysts	Optimal Catalyst Loading	Conditions
Hoveyda- Grubbs Catalyst® M721 Umicore	3–10 mol%	Concentration: (depending on ring size) 1.0 M (5 membered ring); 0.5 M (6 membered ring) Temperature: 40–100 °C

Hoveyda-Grubbs® M721 has been used in the formation of a trisubstituted alkene scaffold used for SAR exploration:[1]

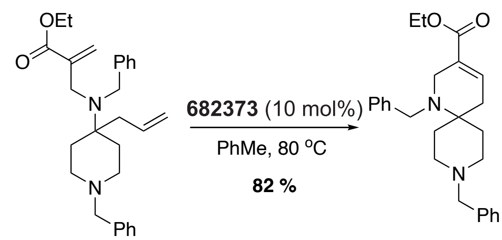


Figure 17. Synthesis of a *N*-substituted pyridyl ring using Hoveyda-Grubbs® M721

The proficient in-telescoped flow synthesis of chiral spiroketones via ring-closing metathesis and hydrogenation, achieving reduced catalyst loading, 70% cost savings, and 60% lower process mass intensity has been reported using Hoveyda-Grubbs® M720.[18]

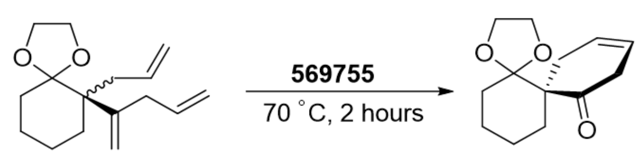


Figure 18. Synthesis of a 6-membered ring using Hoveyda-Grubbs® M720

2. Cross Metathesis

Bringing together two unconnected alkenes in an intermolecular reaction, cross metathesis is an extremely useful reaction that can result in the efficient synthesis of complex and long carbon-carbon chains.

Cross metathesis of electron-deficient alkenes

Preferred Catalysts	Optimal Catalyst Loading	Conditions
Umicore Grubbs Catalyst® M202 Umicore Grubbs Catalyst® M204 Umicore Hoveyda-Grubbs Catalyst® M720 Umicore Hoveyda-Grubbs Catalyst® M730 Umicore Hoveyda-Grubbs Catalyst® M731	1–5 mol%	Concentration: 1.0 M or greater Temperature: 40–60 °C

Grubbs® M220 has been used in the synthesis of biscarbocylic acid, which is used as a precursor to multiple fine chemical products:[19]

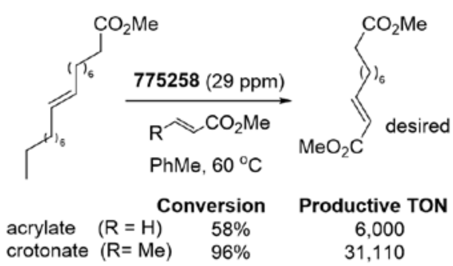


Figure 19. Synthesis of biscarbocylic acid using Grubbs® M220

Hoveyda-Grubbs® M720 has shown to be capable of degrading polyethylene to propylene via tandem partial dehydrogenation, as well as isomerizing ethenolysis (utilizing palladium), achieving over 80% yield.[20]

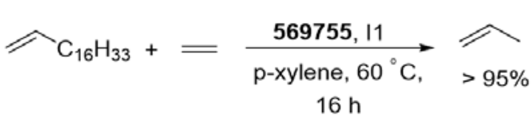


Figure 20. Polyethylene degradation using Hoveyda-Grubbs® M720

Synthesis of ß-lactone structures bearing a variety of alkyl chains at the 3-position.[21]

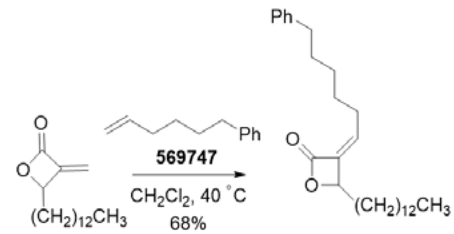


Figure 21. Synthesis of ß-lactones with substitution of the alkenyl chain using Grubbs® M204

Aryloxy phosphonamidate nucleotide prodrugs can be synthesised via ultrasonic-assisted cross-metathesis using a HG-II (M720), achieving 61–82% yields as E/Z mixtures.[22]

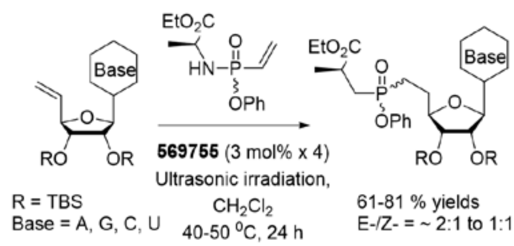


Figure 22. Synthesis of aryloxy phosphonamidate nucleotide prodrugs using Grubbs® M720

Synthesis of trisubstituted linear alkenes

Preferred Catalysts	Optimal Catalyst Loading	Conditions
Umicore Grubbs Catalyst® M202 Umicore Grubbs Catalyst® M204 Umicore Hoveyda-Grubbs Catalyst® M720 Umicore Hoveyda-Grubbs Catalyst® M722 Umicore Hoveyda-Grubbs Catalyst® M730	1–5 mol%	Concentration: 1.0 M or greater Temperature: 40–60 °C

Grubbs® M720 has been used in the preparation of vitamin E intermediates by cross metathesis of trisubstituted and disubstituted alkenes:[23]

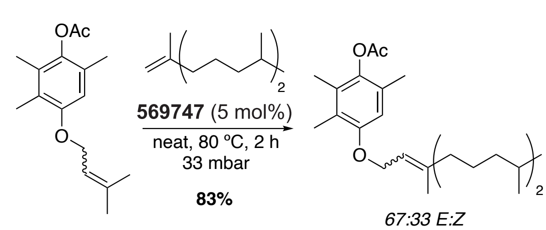


Figure 23. Synthesis of Vitamin E derivatives using Grubbs® M720

3. Ring-Opening Metathesis

Ring-opening metathesis involves the cleavage of cyclic olefins to form acyclic or polymeric products. This reaction is particularly important for strained cyclic alkenes such as norbornene, cyclobutene, and cyclooctene, which can readily undergo ring-opening reactions due to the release of ring strain.

Ring-Opening Metathesis Polymerization (ROMP)

ROMP is a chain-growth polymerization technique that utilizes strained cyclic olefins to generate polymers with well-defined architectures and functionalities.

Hoveyda-Grubbs® M2001 has been used in the controlled ring-opening metathesis polymerization of Dewar azaborinine isomers to synthesize functional polymers with polar B–N heterocycles.[24]

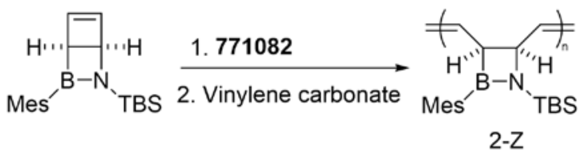


Figure 24. ROM using Hoveyda-Grubbs Catalyst® M2001 for Z- selective polymer synthesis

A combination of Grubbs catalysts M102/M204 has been used in an efficient ring-opening cross metathesis of strained alkenes to dienes without polymerization, with reaction rates strongly influenced by alkene strain, nucleophilicity, and anchimeric participation.[25]

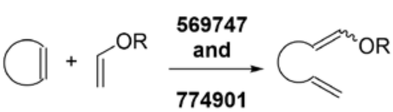


Figure 25. ROM using Grubbs® M204/M102

Grubbs M801 has been used in the synthesis of polymeric multimaterials with stiff (TOR) and elastic (COR) domains. Specifically, a mixed-catalyst system sensitive to visible light enables ROMP of COE with spatiotemporal control over the resultant polyoctenamer backbone stereochemistry.[26]

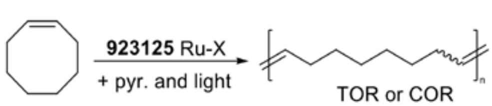
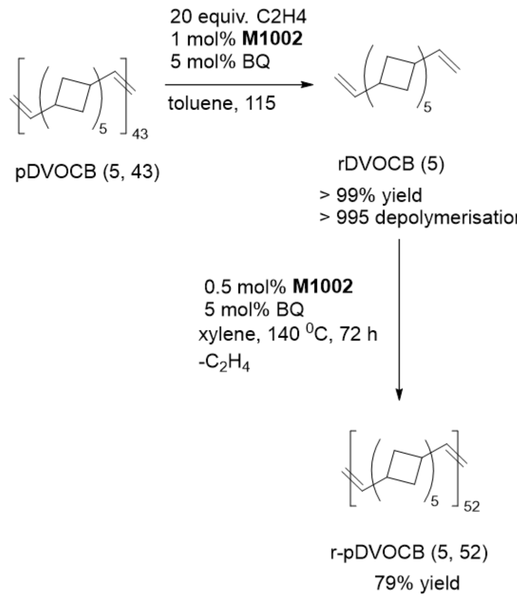


Figure 26. Polymer synthesis using Grubbs® M801

Preferred Catalysts	Optimal Catalyst Loading	Conditions
Umicore Grubbs Catalyst® M102	0.1-5 mol%	Solvent: DCM, DMF Temperature: 40 – 60°C
Umicore Grubbs Catalyst® M204		
Umicore Hoveyda Grubbs Catalyst® M2001		
Umicore Hoveyda Grubbs Catalyst® M800		

4. Other Applications

Grubbs 1001 and 1002 have been used in the de-polymerization and subsequent repolymerization of pDVOCB.[27]



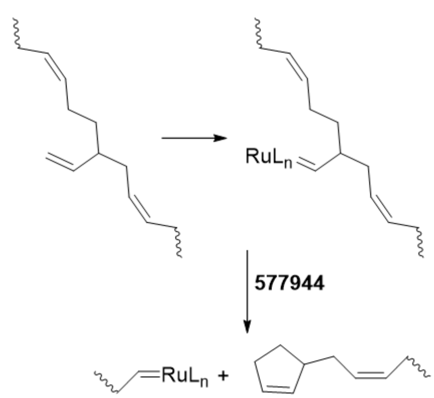
Scheme 3. Depolymerization/repolymerization using Grubbs® M1001 and M1002

Efficient hydrogen production from formic acid has been reported with a first-generation Hoveyda–Grubbs catalyst (M700), achieving a TON of 36,356 in 3 h with only 0.5 µmol catalyst loading.[28]

$$HCO_2H\,(l) \xrightarrow[0.5\ \mu mol,\ 3\ h]{\textbf{577944}} H_2\,(g) + CO_2\,(g)$$

Scheme 4. Hydrogen production from formic acid using Hoveyda-Grubbs® M700

Microencapsulated HG-2 (M700) has also been used in the in-situ depolymerization and chemical recycling of polybutadiene rubber, enabling temperature-controlled release, efficient liquefaction at low catalyst loadings, and recyclability of cross-linked rubbers.[29]

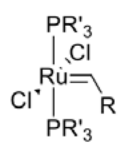


Scheme 5. Depolymerization ofpolybutadiene using Hoveyda-Grubbs® M700

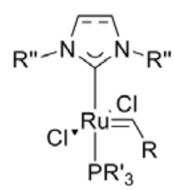
Metathesis Product Guide

Overive of Grubbs Catalyst® Series:

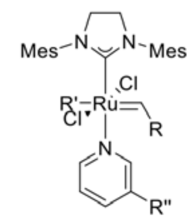
- Grubbs Catalyst® M100 Series: 1st generation - the original, terminal olefin selectivity
- Grubbs Catalyst® M200 Series: 2nd generation - highly active, versatile
- Grubbs Catalyst® M300 Series: Fast-initiating, labile ligands, bench-stable
- Grubbs Catalyst® M800 Series: Latent bis-NHC coordinated, stable at high temperature, thermally activated
- Hoveyda Grubbs Catalyst® M2000 Series: Z-selective - terminal olefin selectivity, high turnover number
- Grubbs Catalyst® M700 Series: Hoveyda-type - highly stable, active at low temperature



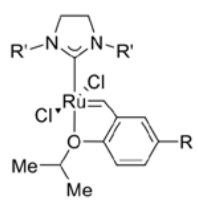
1st Generation Grubbs Catalyst® **M100 Series**



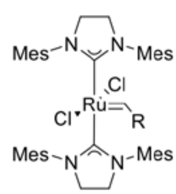
2nd Generation Grubbs Catalyst® **M200 Series**



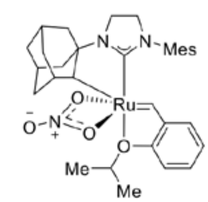
2nd Generation Grubbs Catalyst® **M200 Series**



Grubbs Catalyst® Hoveyda-type
M500 & M700 Series



Latent Grubbs Catalyst® **M800 Series**



Grubbs Catalyst® **M2000 Series** Z-Selective

Figure 27. Representative structures of Grubbs and Hoveyda-Grubbs catalysts.

Product no.	Product name	CAS #	Molecular weight	Description	Structure
774901	Grubbs Catalyst® M101, Umicore	250220-36-1	923.07	For ring-closing metathesis, enyne cycloisomerization, nucleophilic additions of acids to alkynes, and diastereoselective double ring-closing metathesis	R = Ind R′ = Cy
579726	Grubbs Catalyst® M102, Umicore	172222-30-9	710.78	Grubbs Catalyst® 1st Generation: The original catalyst that started it all	R = Cy R′ = Ph
908614	Grubbs Catalyst® M103, Umicore	194659-03-5	800.95	Precursor to a 2nd Generation Grubbs Catalyst® that is effective for forming trisubstituted olefins	R = butenylidene R′ = Cy
915998	Grubbs Catalyst® M104, Umicore	1190427-44-1	828.98	Designed for high-efficiency olefin metathesis. It is well suited for a range of ring-closing and cross metathesis reactions where precise control over olefin formation is desired. Umicore Grubbs Catalyst® M104 is a homogeneous catalyst useful for alkene metathesis, especially for cross-metathesis, ring-closing metathesis, and self-metathesis.	R = 2-thienylmethylene R′ = Cy
775274	Grubbs Catalyst® M201, Umicore	1307233-23-3	1015.11	For ring-closing enyne metathesis, cross metathesis of terminal alkenes with acrylates, and ring-closing metathesis	R = Ind R′ = Ph R′′ = i-Pr
775258	Grubbs Catalyst® M202, Umicore	536724-67-1	949.09	For alkene, cross, enyne, ring arrangement, and ring closing metathesis reactions	R = Ind R′ = Cy R′′ = SIMes
915246	Grubbs Catalyst® M203, Umicore	254972-49-1	947.07	Optimized for challenging metathesis processes, Grubbs Catalyst® M203 delivers consistent performance in both cross and ring-closing metathesis reactions. Its balanced reactivity enables the formation of complex olefin products with high substrate tolerance.	R = Ind R′ = Cy R′′ = IMes
569747	Grubbs Catalyst® M204, Umicore	246047-72-3	848.97	Grubbs Catalyst® 2nd Generation: The most published and well understood	R = Ph R′ = Cy R′′ = SIMes
729353	Grubbs Catalyst® M206, Umicore	373640-75-6	933.13	Bulky NHC ligand results in faster initiation than the Grubbs Catalyst® 2nd Generation	R = Ph R′ = Cy R′′ = i-Pr
682365	Grubbs Catalyst® M207, Umicore	253688-91-4	826.97	A general-purpose olefin metathesis catalyst similar in reactivity to Grubbs Catalyst® 2nd Generation	R = butenylidene R′ = Cy R′′ = SIMes
915742	Grubbs Catalyst® M208, Umicore	1190427-50-9	881.04	A modified 2nd Generation catalyst providing fast initiation and efficiency for cross-metathesis and ring-closing metathesis of sterically hindered substrates.	R = 2-thienylmethylene R′ = Cy R′′ = (Me)2-IMes
915483	Grubbs Catalyst® M209, Umicore	1190427-49-6	852.98	Offering a reliable catalyst performance, Grubbs Catalyst® M209 is designed for synthesizing trisubstituted olefins and building complex molecular architectures. Its balanced activity ensures reproducible results across a broad spectrum of metathesis reactions.	R = 2-thienylmethylene R′ = Cy R′′ = IMes
910430	Grubbs Catalyst® M220, Umicore	1255536-61-8	876.9	For ring-closing metathesis forming trisubstituted C-C double bonds and nitrogen containing heterocycles and cross metathesis of terminal alkenes with acrolein	R = Ind R′ = OiPr R′′ = IMes
682330	Grubbs Catalyst® M300	900169-53-1	884.54	For cross metathesis of acrylonitrile; for ring closing metathesis and the production of lock copolymers by ring opening metathesis polymerisation (ROMP)	R = Ph R′ = 3-bromopyridine R′′ =Br
775282	Grubbs Catalyst® M310, Umicore	1031262-76-6	747.76	For cross metathesis of functionalized allylic alcohols, ring-opening metathesis polymerization, and ring-closing metathesis	R = Ind R′ = none R′′ =H
682381	Grubbs Catalyst® M360	802912-44-3	597.58	For ring opening metathesis polymerisation (ROMP) applications where longer monomer/catalyst resin handling times are desired	R = Ind R′ = none R′′ =H
577944	Hoveyda-Grubbs Catalyst® M700, Umicore	203714-71-0	600.61	For macrocyclization reactions to form disubstituted olefins	R = H R′ = Cy
775398	Hoveyda-Grubbs Catalyst® M710, Umicore	1025728-56-6	737.64	For cross metathesis of terpenoids and formation of trisubstituted alkenes via cross metathesis	R = NHC(O)CF3 R′ = MeS
909165	Hoveyda-Grubbs Catalyst® M711, Umicore	1212008-99-5	821.8	For ring-closing metathesis of functionalized α,ω-diacids and enynes, cross metathesis with methyl acrylate, and formation of trisubstituted alkenes via cross metathesis	R = NHC(O)CF3 R′ = i-Pr
569755	Hoveyda-Grubbs Catalyst® M720, Umicore	301224-40-8	626.62	Hoveyda-Grubbs Catalyst® 2nd Generation: The go-to for any metathesis reaction	R = H R′ = MeS
682373	Hoveyda-Grubbs Catalyst® M721, Umicore	927429-61-6	570.52	For ring-closing metathesis of sterically challenging substrates	R = H R′ = o-tolyl

Product no.	Product name	CAS #	Molecular weight	Description	Structure
729345	Hoveyda-Grubbs Catalyst® M722, Umicore	635679-24-2	710.78	For cross metathesis of sterically challenging substrates	R = H R′ = i-Pr
775428	Hoveyda-Grubbs Catalyst® M730, Umicore	1025728-57-7	741.75	For cross metathesis of terpenoids and ring closing metathesis of functionalized α,ω -diacids	R = NH(CO)OiBu R′ = MeS
775347	Hoveyda-Grubbs Catalyst® M731	1212009-05-6	825.91	M731 offers excellent activity for sterically demanding RCM and cross-metathesis, with high thermal stability and fast initiation.	R = NH(CO)OiBu R′ = i-Pr
916498	Grubbs Catalyst® M800	1383684-54-5	975.1	Developed to operate under demanding reaction conditions, Grubbs Catalyst® M800 ensures rapid initiation and sustained catalytic activity. It is ideally suited for advanced metathesis transformations where high performance and robust kinetics are required.	R = Ind
923125	Grubbs Catalyst® M801, Umicore	508172-19-8	874.99	Highly latent metathesis catalyst that can be mixed with reactive monomers without initiating at ambient temperature, suitable for controlled polymerization and olefin metathesis.	R = Ph
771082	Hoveyda-Grubbs Catalyst® M2001, Umicore	1352916-84-7	632.76	For Z-selective reactions	

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