

# Apeiron's metal scavenging solutions

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Apeiron Synthesis is dedicated to providing transformative products and services to enable our customers to save time and money with cost effective, efficient, sustainable synthetic processes for producing complex molecules.

We endeavor to provide solutions that fully realize the powerful potential of olefin metathesis with efficient and cost-effective chemical pathways for commercial manufacturing processes. Our chemistries have applications across a wide range of industries, including: agrichemicals, fine chemicals, flavor and fragrances, polymers and Pharma/Biopharma. Our ongoing internal research efforts enable us to address the specific challenges that each industry may bring.

Example: Pharma customers have a need to achieve a low metal content in the final product- often as low as single digit ppm levels.

Apeiron's solution: To meet diverse process needs, we have developed two unique, catalyst product lines

- **Solid-supported catalysts** – for heterogeneous use or for easy removal by filtration
- **Self-scavenging metathesis catalysts** – facile removal in work-up (< 5ppm residual Ru)

In addition, we have expanded our toolbox by developing a new line of metal scavengers, for use in R&D and process chemistry applications, to efficiently remove residual catalyst in process.

For more technical information's please review Apeiron's publications, below, and/or contact us directly.

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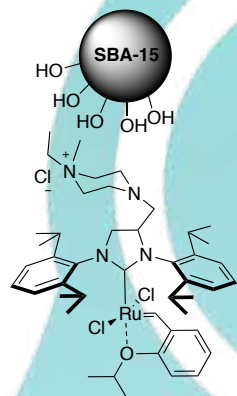
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# Solid-supported catalysts

Advantages of solid-supported reagents have long been recognized and applied extensively to enable metal removal with simple filtration techniques. Apeiron has developed efficient heterogeneous catalysts that eliminate ruthenium contamination in the final product.

## FixCat

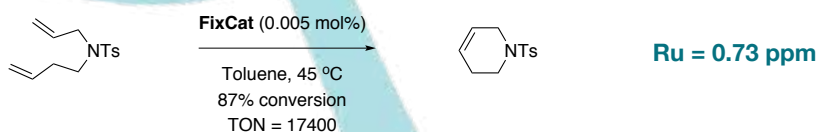
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### Group characteristics

- Easy handling and removal (by simple filtration)
- No leaching - residual ruthenium **< 10 ppm**, often below **1 ppm**
- Excellent CM and RCM efficiency at very low catalyst loadings
- Recyclable for up to 23 runs at 0.1 mol% catalyst loading
- Compatible with multiple organic solvents
- Applicable in continuous flow processes

### Case study: efficiency in exemplary ring-closing metathesis



### References:

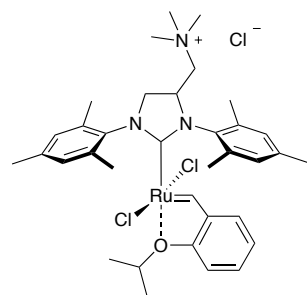
K. Skowerski, J. Pastva, S. J. Czarnocki, J. Janoscova; Exceptionally Stable and Efficient Solid Supported Hoveyda-Type Catalyst; Org. Process Res. Dev., 19 (7), 872–877, (2015)

# Self-scavenging catalysts

For homogenous catalytic systems Apeiron designed self-scavenging metathesis catalysts assuring dual effect: excellent metathesis product yield and residual ruthenium levels below 5 ppm.

## StickyCat Cl

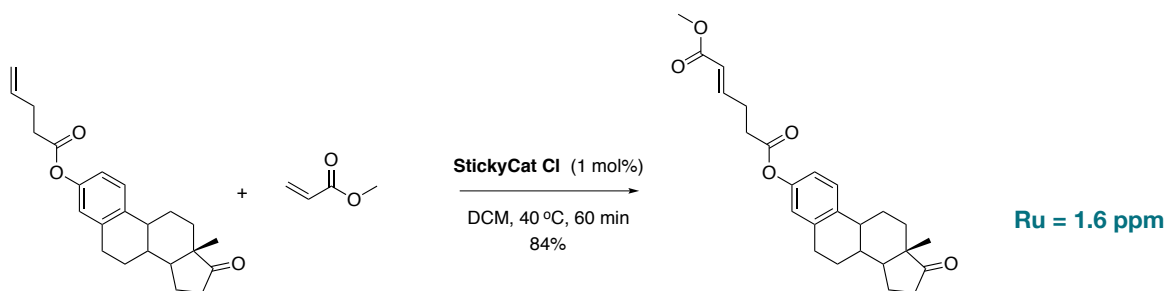
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### Group characteristics

- Simple removal by extraction with water or by silica gel filtration
- Residual ruthenium **< 5 ppm**
- High activity at 40–110 °C
- Compatible with green solvents such as ethyl acetate and water
- High stability in non-degassed water
- Performance modulated by ion exchange

## Case study: efficiency of StickyCat Cl in cross metathesis



## References:

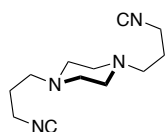
K. Skowerski, J. Pastva, S. J. Czarnocki, J. Janoscova; Exceptionally Stable and Efficient Solid Supported Hoveyda-Type Catalyst; Org. Process Res. Dev., 19 (7), 872–877, (2015)

## Reaction quenchers/metal scavengers

Metal salts and metal complexes used in many reactions leave traces that affect product quality and can falsify biological screening. Metal scavengers developed at Apeiron are a universal solution for metal removal.

### SnatchCat

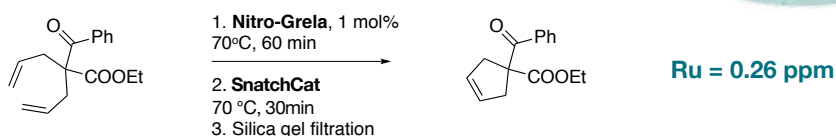
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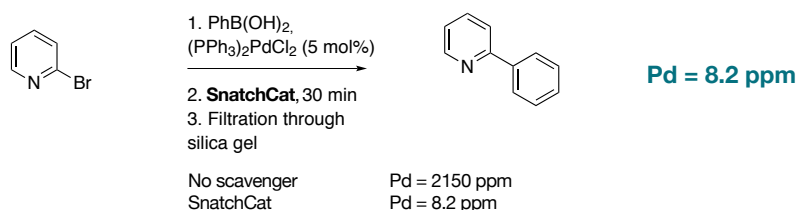
#### Group characteristics

- High efficiency – Ru/Pd content < 10 ppm
- Fast acting - 30 min scavenging time
- Immediate reaction quencher
- Simple workup - flash silica gel filtration
- Compatible with broad range of functional groups and solvents
- Facile handling - stable, non-toxic, non-volatile, odor-free

## Case study: ruthenium scavenging after ring closing metathesis removal



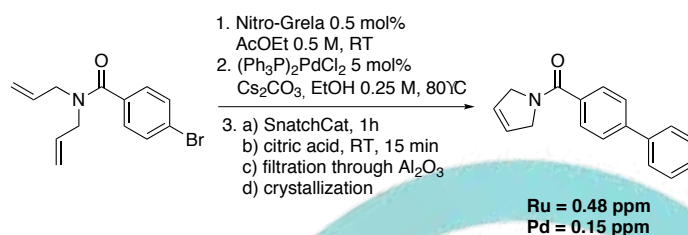
## Case study: palladium removal after Suzuki coupling



## References:

G. Szczepaniak, K. Urbaniak, C. Wierzbicka, K. Kosiński, K. Skowerski, K. Grela; High performance isocyanide scavengers for use in low-wastepurification of olefin metathesis products; ChemSusChem 8, 4139–4148, (2015).

## Case study: removal of ruthenium and palladium products from telescope RCM/Suzuki–Miyaura sequence



### References:

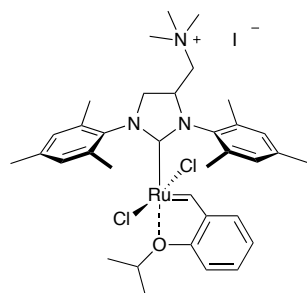
G. Szczepaniak, A. Ruszczynska, K. Kosinski, E. Bulska, K. Grela "Highly efficient and time economical purification of olefin metathesis products from metal residues using an isocyanide scavenger" DOI: 10.1039/c7gc03324a

## Self-scavenging metathesis catalyst working synergistically with metal scavengers

Apeiron has optimized its catalysts to function in concert with our metal scavengers to dramatically lower residual ruthenium levels. This approach is particularly well-suited for use where polar products with high ruthenium affinity present a complicated purification challenge, as is often observed in API production.

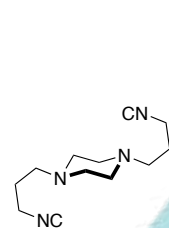
### SickyCat I

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### SnatchCat

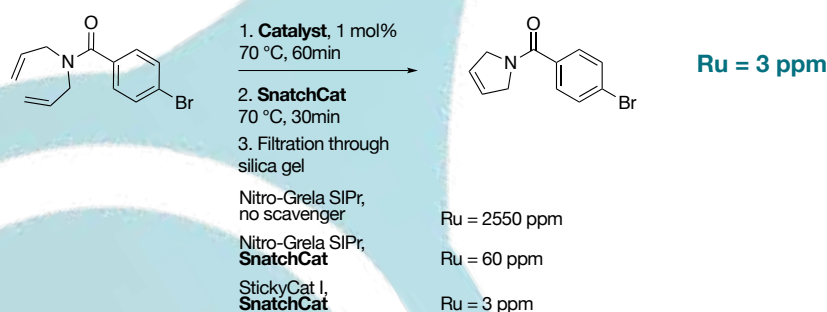
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PCT/EP2014/406739



### Group characteristics

- High efficiency – Ru content < 10 ppm
- Fast acting - 30 min scavenging time
- Immediate reaction quencher
- Simple workup - flash silica gel filtration
- Compatible with broad range of functional groups and solvents
- Facile handling - stable, non-toxic, non-volatile, odor-free

### Case study: reduction of ruthenium content after ring closing metathesis



### Typical procedure for metal scavenging

Add 4.4 eq of **SnatchCat** to a crude mixture containing metal ions or a catalyst (most effective solvents: toluene, dichloromethane, ethyl acetate). Stir for 30 minutes at room temperature. Filter through a silica pad (200 mg of silica gel 60 (230–400 mesh) per 1mg of metals/catalyst). Note: scavenger equivalents, temperature as well as amount of silica gel for reactions of interest can be individually optimized.

### References:

G. Szczepaniak, K. Urbaniak, C. Wierzbicka, K. Kosiński, K. Skowerski, K. Grela; High performance isocyanide scavengers for use in low-waste purification of olefin metathesis products; ChemSusChem 8, 4139–4148, (2015).

### Technical support

• General help: [info@apeiron-synthesis.com](mailto:info@apeiron-synthesis.com)

• Ordering mail: [sales@apeiron-synthesis.com](mailto:sales@apeiron-synthesis.com)