Technical note

# Mechanochemistry on Thermo Fisher Scientific twin-screw extruders using heterogeneous catalysts

## Introduction

Many organic synthesis reactions require the use of catalysts to achieve the desired reaction rate, selectivity, or yield. In general, catalytic processes can be classified as either homogeneous or heterogeneous. In homogeneous catalysis, the catalyst is present in the same phase as the reactants. In heterogeneous catalysis, the catalyst is typically present as a solid phase, enabling easier separation from the reaction mixture and potential reuse after the process.

This application note explores an approach for implementing heterogeneous catalysis in mechanochemical reactions carried out on a Thermo Scientific™ Twin-Screw Extruder. In particular, it considers the use of catalytically active screw elements as part of a modular extrusion setup.

## Modular twin-screw extruder design

Thermo Scientific Twin-Screw Extruders are designed with modular screw configurations. Individual screw elements can be freely arranged on a shaft to match the requirements of a specific process or application. This modularity provides significant flexibility in optimizing mixing, conveying, kneading, residence time, and energy input.

Beyond their mechanical function, selected screw elements may also be used as catalytically active components within the reaction zone. This opens new possibilities for combining continuous mechanochemical processing with heterogeneous catalysis.

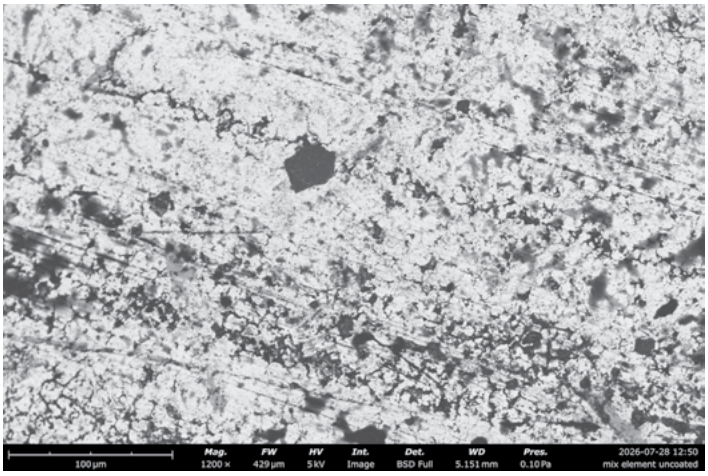
Thermo Scientific™ Process™ 11 Twin-Screw Extruder

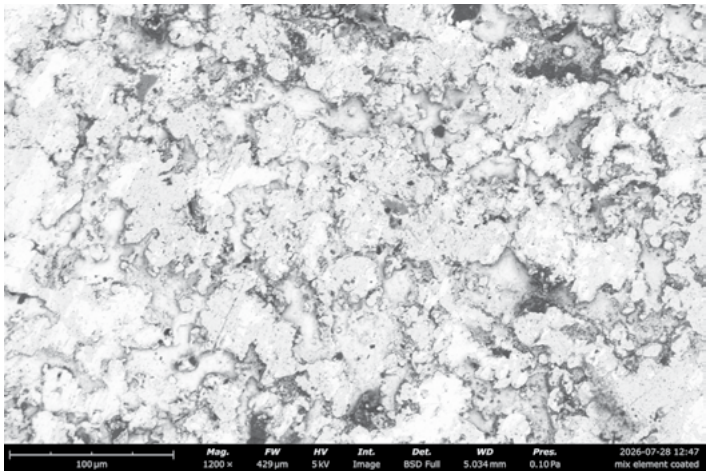
## Coated screw elements

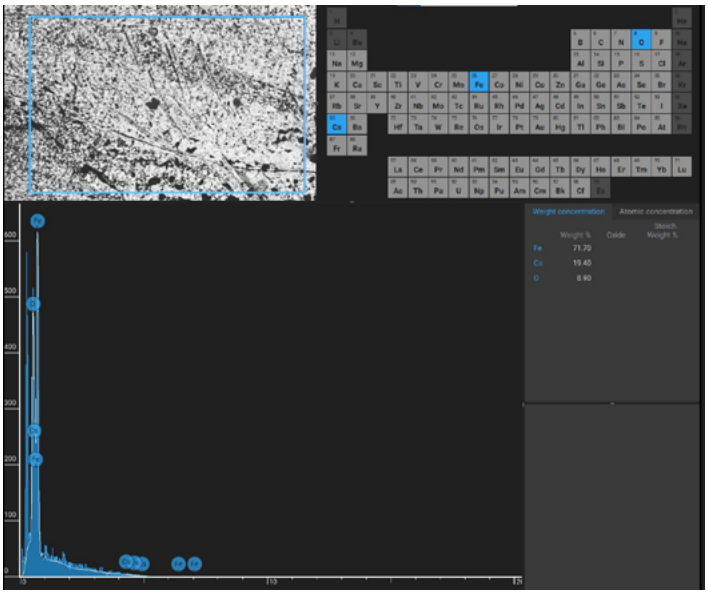
One practical approach is to coat individual screw elements with a suitable catalytic material. For this purpose, a LUXOR™ SEM Coater from Aptco Technologies can be used to apply a thin metal coating to selected elements.

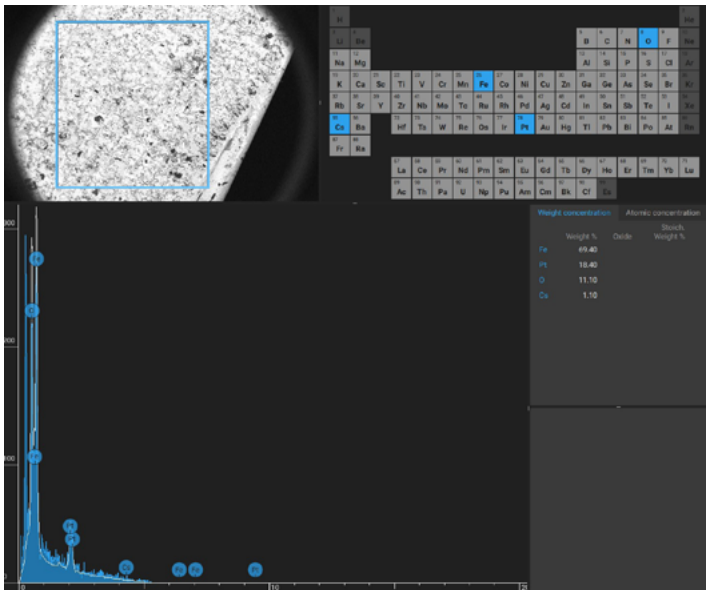
The coating process is efficient, precise, and can be completed within a short time. Depending on the reaction requirements, available coating materials include gold, platinum, and palladium. Other metals may be available upon request.

By integrating coated screw elements into the extruder configuration, the catalyst becomes part of the processing hardware. During operation, the reactants are continuously conveyed and mechanically activated while coming into direct contact with the catalytic surface.









Left: Uncoated mixing screw element.

Right: Platinum-coated mixing screw element.

## Catalyst reconditioning and reuse

Over time, catalytic activity may decrease due to contamination, deposits, or abrasion. In such cases, the affected screw element can be removed and recoated using the LUXOR™ Sputter Coater. This enables straightforward regeneration of the catalytic surface and supports repeated use of the screw element in subsequent experiments or processes.

## Benefits for mechanochemical synthesis on a Thermo Scientific Twin-Screw Extruder

The use of catalytically coated screw elements in twin-screw extrusion offers several potential advantages:

- Integration of heterogeneous catalysis into a continuous mechanochemical process
- Direct contact between reactants and catalytic surfaces under mechanical activation
- Modular placement of catalytic zones within the screw configuration
- Simplified catalyst handling compared with particulate catalyst addition
- Potential for recoating and reusing catalyst-bearing elements

## Conclusion

Combining mechanochemistry with heterogeneous catalysis on a Thermo Scientific Twin-Screw Extruder creates new opportunities for continuous synthesis processes that require catalytic activation. The modular screw design of the twin-screw extruders enables selected screw elements to be functionalized with catalytic coatings, such as gold, platinum, or palladium.

This approach expands the application range of twin-screw extrusion in mechanochemical synthesis and provides a flexible platform for developing catalyst-assisted reactions in a continuous processing environment.

Learn more at **thermofisher.com/extruders**

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