

## **3D printed catalytic static mixers – a new continuous flow solution for hydrogenations**

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### **Abstract**

Hydrogenations are a reaction class of major interest for almost all sectors of the chemical manufacturing industry, and efficient engineering solution for the chemical apparatus used in these operations are in high demand. Over the past years, CSIRO has developed a new tubular reactor system for heterogeneously catalysed hydrogenations using a versatile, structured catalyst platform. This immobilised catalyst system, termed Catalytic Static Mixers (CSMs), consists of a catalytically active 3D printed metal structure, inserted into a tubular reactor. The static mixers can be coated with a range of different catalytic layers, using several different deposition methods such as metal cold spraying, wash coating and electroplating. A range of noble metal CSMs have been produced so far, including variations of Ni, Pd, Pt, Rh, Ru and Au catalysts, with or without metal-oxide support. CSMs are much easier to handle than packed beds and can, in principle, be (retro)-fitted to any tubular, rectangular or other continuous flow reactor geometry. Tubular devices have a series of advantages over classical packed bed reactors or batch slurry stirred tanks, such as high L/D ratios leading to excellent control over the chemical process, well defined flow patterns and a predictable and low pressure drop. To date, a range of hydrogenation reactions have been investigated, including the reduction of alkenes, alkynes, aldehydes, nitro- and diazo-compounds, nitriles, imines, and aryl halides. These reductions are model systems for industrial applications in the pharmaceutical, fine chemistry and related industries, and showcase the versatility and efficiency of the CSM technology.