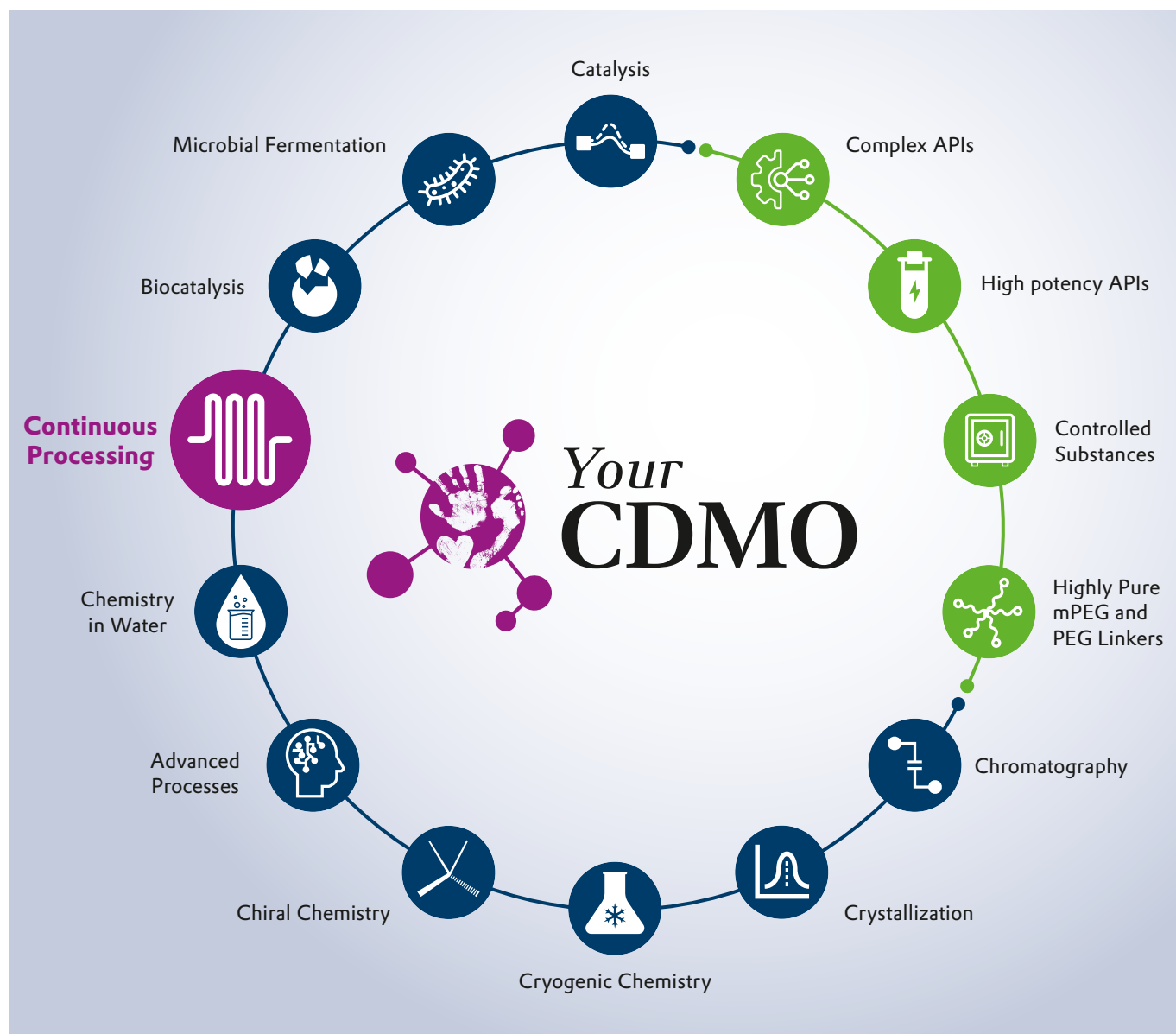


Continuous Processing

From process understanding to reliable continuous manufacture



- 1 Development, pilot production and commercial manufacturing
- 2 Engineering and in-house process skid construction
- 3 Over 50 years of expertise, combined with solid cGMP quality track record

CONTINUOUS PROCESSING – A POWERFUL TOOL FOR HIGH VALUE PRODUCT MANUFACTURING

Evonik applies continuous processing where it creates real benefit:

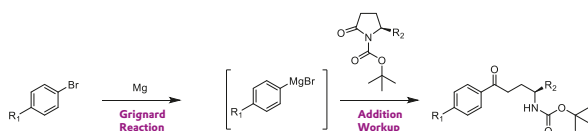
- **Enhanced safety** for exothermic or hazardous chemistry through reduced hold-up
- **Improved quality and yield** by controlling residence time, heat transfer and stoichiometry
- **Economic efficiency** through process intensification, smaller footprint and robust scale-out
- **Informed decisions:** Flow is selected where it adds measurable value over batch



Example

CONTINUOUS GRIGNARD FORMATION AND ADDITION TO AN ELECTROPHILE

- Grignard formation in a CSTR
- Highly efficient plug flow reactor for continuous addition to the electrophile



95 %
reduction of
hazardous
material in
plant

44 → 61 %
yield increase
for sequence

17 → 15 %
PMI
improvement

97.6 → 99.2 %
Purity
enhanced



Technology Features

Evonik combines chemistry, engineering, analytics and automation to find the optimum process.

Technology platforms

- CSTRs, plug flow reactors, loop reactors, trickle bed reactors photo reactors and many others
- Continuous extraction, distillation, chromatography, crystallization and isolation techniques
- PAT enabled process monitoring incl. IR, NIR, Raman, FBRM, NMR and many others.
- Process simulation and additive manufacturing

Supported chemistries

- Cryogenic, organometallic and highly exothermal reactions
- Hydrogenations and other multi-phase reactions
- Alkylations and acylations
- Polymerizations
- Photochemistry
- Many others ...

Supported scales and phases

- Laboratory process design and development
- Flexible pilot plant
- Multi purpose or customized manufacturing solutions
- US and EU based ISO and FDA inspected cGMP manufacturing sites

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