Since its creation, CSEM has been a cornerstone of technology development and transfer for precision microtechnologies (our DNA) and digitalization technologies. These intelligent technologies are the foundations on which smart systems are built, promising all industries new opportunities for economic growth.

CSEM has long been renowned as one of Switzerland’s major research institutes—in the precision manufacturing domain as well as in advanced microelectronics and microtechnology—with our innovations being eagerly adopted by several key partners, including in the watchmaking industry.

Pushing ahead into the new digital economy, our expertise has spawned advanced technologies, analytics, and algorithms, enabling the industrial IoT (IIoT) and strengthening manufacturing processes. In domains as diverse as health, energy, aeronautics and space, security, agriculture, and consumer electronics, CSEM provides its partners with the personalized tools, hardware, and software they need to take them forward into the digital age.

From precision manufacturing and renewable energies to digitalization technologies, we provide the expertise, technologies, processes, and services that can deliver a decisive advantage to all our industrial partners. CSEM is committed to advancing digital technologies in the economy across a competitive and global industrial environment. With 400+ experts, we are passionate about helping our partners achieve success in our rapidly evolving world.
Additive manufacturing

Welcome to a new world

Additive Manufacturing (AM) technologies are a vital aspect of the fourth industrial revolution. Together with digital technologies, they are enabling *Smart Factories* and changing the face of the manufacturing industry.

Making new shapes possible, simplifying production steps, shortening the time to market, and saving materials, AM opens up exciting new horizons and perspectives on cost reduction.

CSEM’s focus is on precise, functional metal and polymer AM technologies that have a throughput compatible with their industrial application, including on their hybridization with other manufacturing technologies. Thanks to this approach, we have developed advanced skills in the design, prototyping, and preproduction of precise and complex components and systems.

Today, we are able to address a wide range of applications in many industries and we place this know-how at your service.

We offer you a powerful ecosystem composed of advanced design software as well as cutting-edge additive manufacturing and quality control equipment. You’ll also—and above all—find the human and technical skills capable of ensuring all the essential steps that lead to your commercial success.

Let’s put that expertise to work.

- Design & redesign
- High-accuracy manufacturing
- AM meets microsystems
- A unique ecosystem
01: AMAR—Patented redesign of a slip ring assembly rotor. Built-in electrical functions; parts reduced from dozens to one.

02: TOPCAM—Topology optimization and selective laser melting (SLM) process simulation for geometrical error compensation.

03: AMFLEX—Flexure pivot; design adapted to SLM.

04: TOPCAM—Topologically optimized monolithic flexure pivot including interlocked flexures (patent pending).

05: AMTI—Topologically optimized monolithic tilt mechanism for a deflection mirror.
By mastering design rules and tools, we help you to maximize the benefits of additive manufacturing

**Optimization**: Advanced design tools and the freedom native to AM design makes highly optimized parts and products possible. Perfecting mass, volume, eigen modes, or thermal conduction makes a real difference when performance is decisive.

**Streamlining**: Product complexity can be drastically reduced by merging several parts—even dozens—allowing substantial cost savings and increased reliability.

**Adding new, built-in functions** increases end products’ added value.

- **Integrated power and signal routing** by printing electrical wires inside structural metallic parts, CSEM’s patented and proven technology opens the door wide to the design of parts featuring advanced, built-in functions such as sensors.
- **Integrated mobile parts** based on built-in printed flexure elements can replace ball or friction bearings, guaranteeing infinite motion lifetime, even in harsh or stringent environments (space; corrosive; ultra-clean).
- **Heating or cooling channels** can be integrated into mechanical parts—a significant asset when a part has to be thermalized (molding industry; vacuum technologies).

Thanks to their digitalized design, AM parts and products are ready for production in the workshops of tomorrow: Smart factories, which promise highly optimized production flow and quality assurance.

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**AMX Innovation award**

CSEM’s patented design concept based on AM was used to redesign the rotor of a slip ring assembly for space applications—a flagship product of Switzerland’s RUAG Slip Rings SA. The product redesign enables the production of parts featuring built-in electrical functions. It also delivers drastic simplifications and consequent reductions in production costs. This innovation received the Innovation Award at the AMX fair in Lucerne in 2018.
01: 100 μm lattice structure in stainless steel
02: Stainless steel watch pallets
03: Stainless steel watch escapement wheel
04: Compliant mechanism made of interlocked lattice structure
05: Passive fluidic valve
06: Simulation of a passive fluidic valve
When precision matters

Thanks to our specific know-how in process optimization on the micro scale, we leverage the advantages of AM for small components (<1 cm).

**Efficiency:** Reducing the number of assembly steps for complex shapes, AM’s native freedom of design is particularly useful for small parts, which are difficult to handle and manufacture conventionally.

**Lightweight and sustainable:** drastically reducing the quantity of material required to form a stable component.

**Time and cost savings:** material savings and shorter manufacturing times.

**Mass customization:** the flexibility to produce tailor-made objects or small series without additional costs.

We are constantly pushing the miniaturization limits in **powder bed fusion** in order to offer high-accuracy manufacturing for materials such as stainless steel, titanium alloy, and aluminum alloy.

Our experts also have advanced skills in post processing—a crucial step in maximizing your output quality.

CSEM also offers high accuracy micromanufacturing from polymers, using technologies such as UV stereolithography (UV-SLA) and with minimum dimensions as small as 20 μm.

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**Small metal components**

A particular focus is on making SLM (or powder bed fusion) technology suitable for the small volume production of mechanical microcomponents for instrumentation, in particular for the watch industry. The use of the third dimension for topology optimization and novel functionalities is a motor for innovation as well as a way to simplify mechanisms by avoiding assembly steps.
01: Aerosol jet printer
02: Micro-mirror with a 3D-printed shock stopper (backside view)
03: Broken micro-mirror with a 3D-printed shock stopper (frontside view)
04: Printed strain gauge on a 3D structure
05: Fluidic channel on a CMOS imager
06: Example of alignment of a fluidic channel on a CMOS imager
AM MEETS MICROSYSTEMS

Toward new devices and functionalities

Combined with traditional manufacturing technologies, AM enables us to change the way components and devices are manufactured, giving them new functionalities.

In microsystems—which rely on high-precision fabrication methods such as MEMS, CMOS, packaging, micro-molding, and micro-assembly—multi-manufacturing technologies are used.

CSEM expertise in precision AM and 3D printing in the sub-100 μm range make these technologies suitable for microsystems. New functionalities that are difficult or impossible to implement by other means can thus be added, creating significant differentiation.

Moreover, printing directly onto components has the major advantage of reducing costly, time-consuming precision assembly steps. And we have applied this concept to precision instrumentation, medical devices, and watch components.

Micro-mirror with shock stopper

To fulfill requirements regarding the transportation and portative regulation of electronic devices, a shock-stopper was directly fabricated by 3D printing onto a silicon-based micro-mirror, allowing a shock resistance of around 1000 g.

In this specific case, 3D printing brings with it the advantage of significant design freedom, the absence of the assembly step, and the upscaling potential for production at the wafer level.
01: Tensile tester with extensometer
02: Micro-stereolithography printer with alignment camera
03: Material engineering & reliability evaluation from nano to macro scale
04: Micro-stereolithography printer with alignment camera
05: Meso scale—Measuring mechanical properties on a scale between the microscopic and macroscopic
06: Precision 3D laser scanner
Every step counts

For SMEs or for bigger companies, CSEM is the ideal place to “catch the AM train”. In a rapidly and constantly evolving environment, our experts help you to **minimize your risks** thanks to their perfect mastery and understanding of the entire technological chain.

Our manufacturing experts define the relevant printing parameters, choosing the best powders and working for the reproducibility of your products and components. This process can also receive significant support from our **characterization and reliability** team, which verifies and tests the performance of the object we are, together, developing.

As our mission is technology transfer, we bring you the know-how required to move further into the AM world, so that your business gets the most out of this extraordinary technology.

**Connected**

CSEM is a member of the Micro-Manufacturing Science and Engineering Center (M2C), which brings together CSEM, EPFL, the Haute Ecole ARC, and the University of Neuchâtel. We are also part of the AM-TTC Alliance, a Swiss initiative dedicated to advanced production technologies.
Expertise and infrastructure portfolio

**Design software**
- Computer assisted design (SolidWorks)
- Optimization (Altair OptiStruct and Inspire)
- Additive manufacturing process simulations (Amphyon)
- Multi-physics simulations (COMSOL)

**Available printing technologies**
- Powder bed fusion
- Fused filament fabrication
- UV stereolithography
- Multi-material printing
- Aerosol jet printing
- Ink-jet printing

**Material characterization & part quality control**
- Precision 3D laser scanner
- Height gage
- Roughness tester
- Optical inspection and measuring systems
- Endoscopes, stereomicroscopes, 2D vision system
- Powder flowability and tapped density
- Microstructure
- Chemical composition
- Mechanical properties at the meso and macro scale (density; Young modulus; tensile strength; hardness)

**Reliability & fatigue analysis**
- Thermal cycling
- Thermal storage
- Mechanical shock
- Vibration
- Bending fatigue
- Rotating bar bending fatigue test
CSEM is involved in every step of the AM process

- System & functions
- Design optimization
  - AM method
  - Heat treatment
  - Materials
- Manufacturing
- Testing
- System integration
- Functionality testing