

Grandprix EPHJ 2018 Dossier

Innovative <smart> Components for New Medical and Industrial Products Technology Platform for Next Generation Micro-Devices

Abstract

Acquandas GmbH (Kiel, Germany) a global OEM supplier, offers a unique technology platform to design and fabricate customized **bioelectronic & micro-technology components and smart actuators** for high-tech markets. This innovative technology platform uses certified medical materials and can be engineered to design and build new flexible ultra-precise micro-components in 3D from anti-magnetic Nitinol (Nickel-Titanium alloy, a super-elastic or shape-memory metal) or various other metals. Different materials can be combined in single- or multi-layer stacks on a micro-scale which is a technological breakthrough as it links active or sensory innovations to micro-mechanics: It offers designers and developers the **integration of diverse miniaturized <smart> features on a super-elastic carrier**, thus being a key technology platform for modern medical and industrial products. ACQUANDAS disruptive technology enables kinetic minimal-invasive medical (e.g. micro-implants, bioMEMS, (medical) wearables/smart watches) or industrial micro-devices (e.g. actuators, mirrors, precision tooling, soft robotics, cutters, knives or springs).

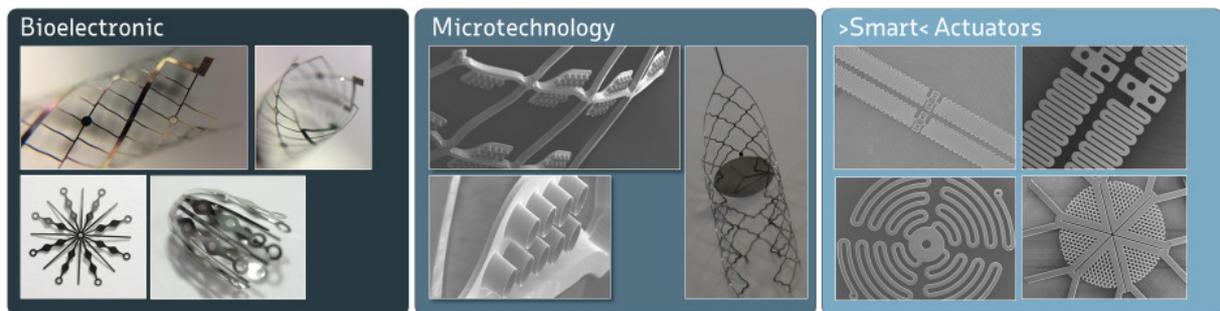


Figure 1: Overview of different flexible ultra-precise micro-components for medical and industrial markets. **Left:** Flexible metallic carriers equipped with micro-electrode arrays for bioelectric sensing/stimulation **Center:** Monolithic Nitinol micro-components with complex geometries **Right:** Micro-springs and actuators

Background

Nickel-Titanium Alloys (Nitinol) are biocompatible, anti-magnetic and metallic materials that offer tremendous mechanical properties. The unique material properties (due to a phase transformation between two crystallographic phases, i.e. the austenitic and the martensitic phase) make them suitable for a variety of flexible precision applications. In life-sciences they are the number #1 choice for minimal-invasive medical devices, because they can be folded tightly and expanded during deployment in a vessel. In addition, Nitinol is one of the very few certified (USA, Europe, Japan, Asia) biomaterials for long-term vascular implants and minimal-invasive medical micro-devices. Certified materials are utmost necessary to simplify and shorten developments and access these markets, because of regulatory requirements. Industrial markets use Nitinol materials mainly due to their spring, damping, and actuation characteristics, as they are superelastic - can be elastically stretched like no other metal, have a high work output, and can be miniaturized in micro-scale and colored easily.



Figure 2: Examples for classical micro-mechanics applying ACQUANDAS technology. **Left:** Balance spring from amorphous anti-magnetic Nitinol **Right:** Magnification of high density and flexible electric connection interface

For the “Maker”: Engineering on a micro-scale with high design freedom and endless customization

ACQUANDAS patented technology combines various methods of microsystem technology: magnetron sputtering (a vacuum deposition method), UV lithography and chemical etching (Figure 3). The unique combination of these processes allows the fabrication of novel micro-components and implants.

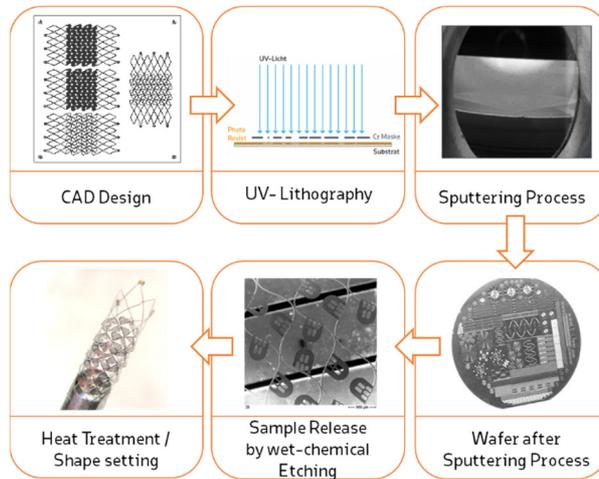


Figure 3: Processing steps for manufacturing customized components in micro-scale

The building process for customers requires a 2D CAD drawing of the component. ACQUANDAS produces a 2D Nitinol structure on a standard Silicon wafer carrier, either as a single-layer or in combination with additional materials. After releasing the structure from the wafer carrier by wet chemical etching, a final heat treatment/shape setting process is applied to form a flexible and precise 3D geometry, like origami.

| | Geometry | Profile / Cross Section | Example |
|---|----------|-------------------------|---------|
| 2D Structures | | | |
| 2.5D Structures | | | |
| Integrated Functionality / Multi-layers | | | |
| Coatings | | | |

Figure 4: ACQUANDAS fabrication patterns - geometry & profile options for 2D / 2.5D / 3D

ACQUANDAS provides a technology platform for small, complex and precise 2/2.5D/3D geometries (Figure 4) from ultra-pure materials and customized alloys, with micro tolerances in thin (~1 μm) and thick (up to 80μm) dimensions. It enables the production of highly flexible metallic structures and options to add dissimilar materials that were expensive or simply not possible to produce with traditional subtractive processes on the micro-scale, i.e. traditional design restrictions do not apply anymore. Also, design and assembly complexity does not come at additional cost during the production process. The opportunity for companies to add customization as a premium option to their existing range or next generation products is also huge. With this new technology platform ACQUANDAS opens the engineering space and freedom of design to the industry. A micromachining reference in the industrial manufacturing of super-elastic micro-devices. The fabrication process is, like computer chip technology, based on batch processes and is cost competitive, and can be scaled and automated to reduce further costs.

Innovative Application Areas

Besides classical precision mechanics (e.g. advanced springs – anti-magnetic balances or micro-springs for snap-fit/sealing, high density/flexible connectors, switches, contacts etc. Figure 2), new examples for applying this technology in the precision and watch industry are innovative micro-devices for medical health or fitness with

e.g. electronic micro-systems or implants (called bioelectronics). Intelligent micro-implants promise a revolutionary future as these devices interact over the peripheral circulatory or nerve system to form interfaces for bio-feedback or medical therapies. Therefore, integrated technology systems will become a significant medical treatment or diagnostic method and will simplify interfacing with the human body (Figure 5). For these devices extra functionality (e.g. electrical) must be integrated with a very small foot print on top of biocompatible mechanical carriers. ACQUANDAS technology platform is one of the key enabling technologies of important future <smart> systems and methods (e.g. sensors, medtech devices etc.). New micro devices with additional biomedical features and bio-interfaces are required to facilitate more efficient and cost-effective diagnostics and therapies. Isolating and conducting electrode materials (e.g. SiOx, Pt, PtIr, IrOx) are combined to realize flexible isolated integrated electrical circuits or antennas on top of the super-elastic and biocompatible Nitinol carrier. Such engineered components and implants offer additional integrated functionality: for example, bioelectric sensing or stimulation by means of electrical, physico-chemical, chemical, optical or magnetic features.

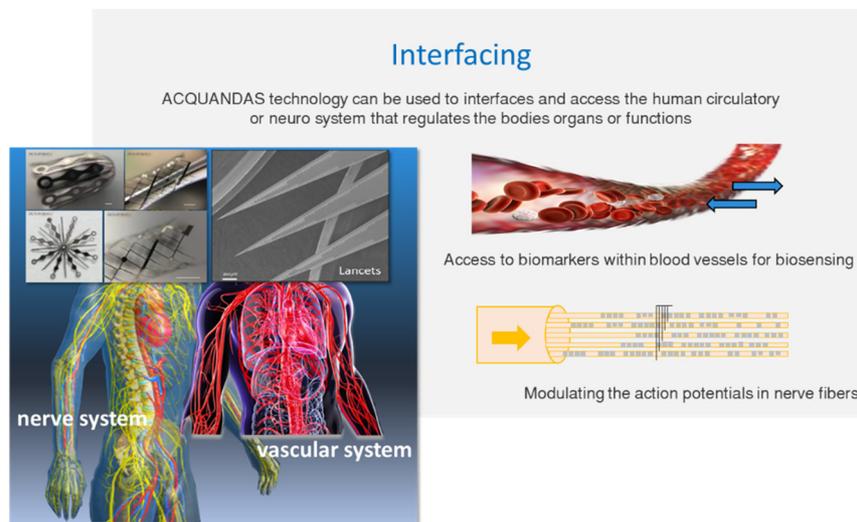


Figure 5: Applying micro devices for medical/health: interfacing with the human nervous or vascular system requires <smart> micro-devices with certified materials and innovative technologies for sensing, stimulation or sampling

Summary

Today's precision markets look for new technologies to build innovative micro-devices with <smart> features (e.g. anti-magnetics, damping, actuation, sensing). Also, certain industries look to enter new markets. For example, an increasing number of watchmaking companies are putting their expertise to good use by diversifying into the medtech sector where interfacing to the human body is a key requirement. (Bio)materials and processes for general use for these applications are very limited. Innovative platforms to integrate more features, reduce costs, simplify assembly processes and offer more customer differentiations are necessary. This is very complex, challenging and almost impossible with today's established materials and manufacturing processes - such as lasering, turning, milling, EDM and grinding.

Designers and industrial engineers all over the world have been educated and experienced throughout their lives to think within the confines of established production restrictions. Applying ACQUANDAS technology platform they are just beginning to understand that the limit of design is also one's own imagination and that is a revolutionary paradigm shift that will take years to become embedded.

About Acquandas GmbH

Acquandas GmbH - a private company - was founded in August 2012 and is located in Kiel, Germany. ACQUANDAS serves and supports its global customers from the first technological implementation of a product idea with added value by customizations and <smart> features to an optimized, manufacturable solution and offers prototype and serial production capabilities.