



New Generation of Flexible Sensors and Actuators Based on Conductive Silicone

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About SATECO Group



Pioneer in silicone keypad technology for the Automotive industry

Experience

- Co-develop haptic branding with OEMs
- >20 years of proven automotive supplier track record
- 250 million keypads produced each year
- continuous improvement, zero defect strategy and IATF 16949 quality standard

Mission

- producer of unique silicone HMI components
- in-house testing and qualification
- support from specific design towards integration
- best-in-class application support

Silicone Technologies

Surface

- Decoration
- Seamless HMI interaction

Visual effects



Sensor

- Continuous control
- Tactile and media pressure
- Flow, fill level

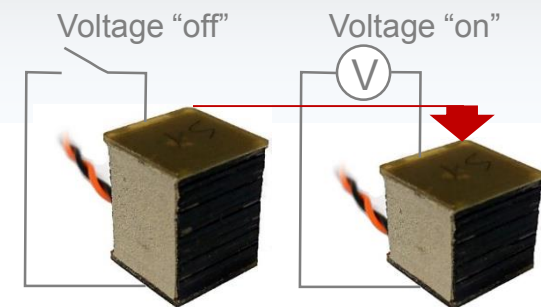
Continuous force signal upon pressure



Actuator

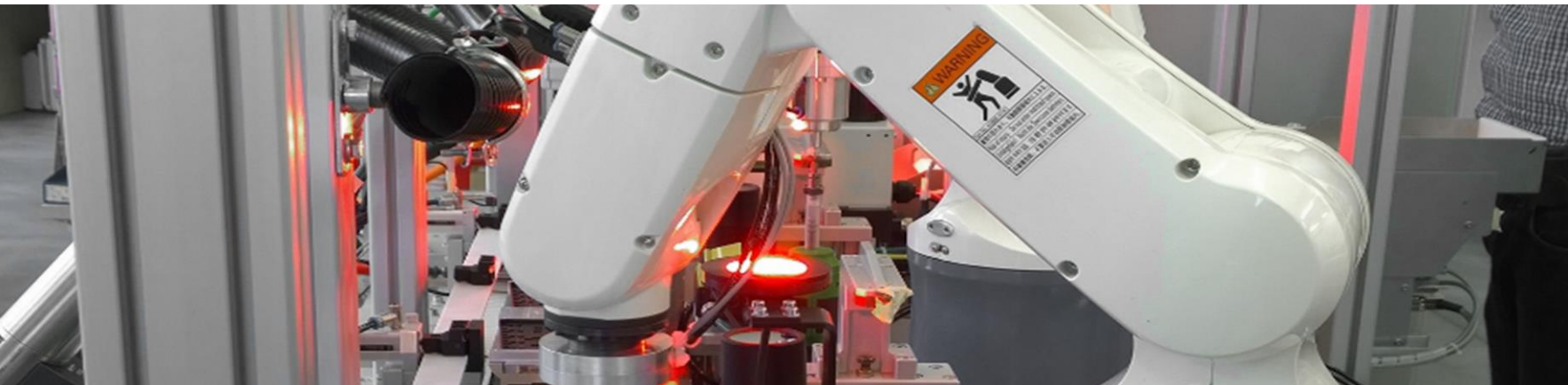
- Shape changing,
- Tactile feedback,
- Fluid control (valve, pump)

Contraction or vibration upon applying voltage





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Flexible Sensors

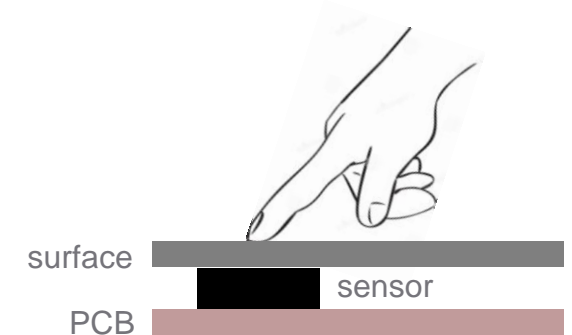
- Continuous control
- flexible, bendable
- Absorbing impact, friction

Capacitive-type Sensor



Variable pressure sensing and control

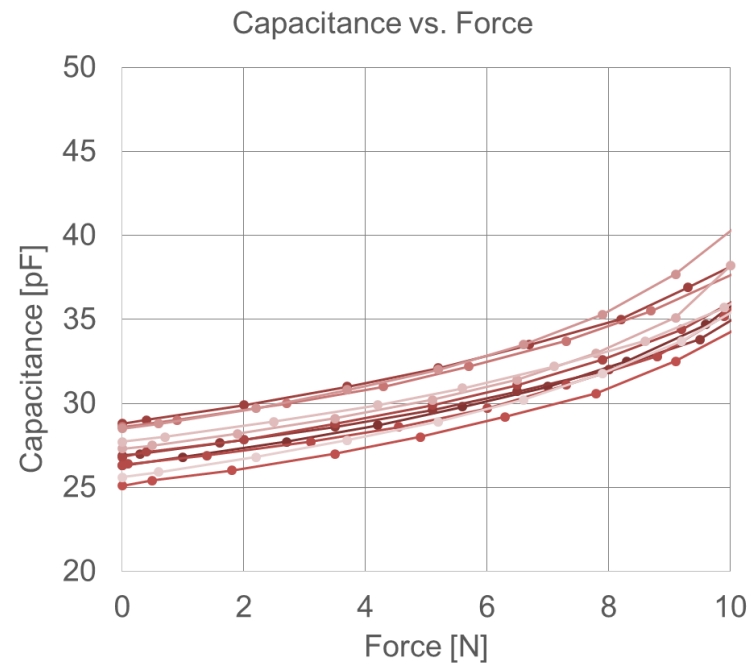
- Two-in-one: wake-up and control
 - Dosing (volume)
 - Speed, e.g. ventilator, mixing
 - Concentration
- provides quasi-static haptics
 - Force: up to several 10N,
 - Stroke: 0.1...1.0mm.
- Shape can be tailored to space.



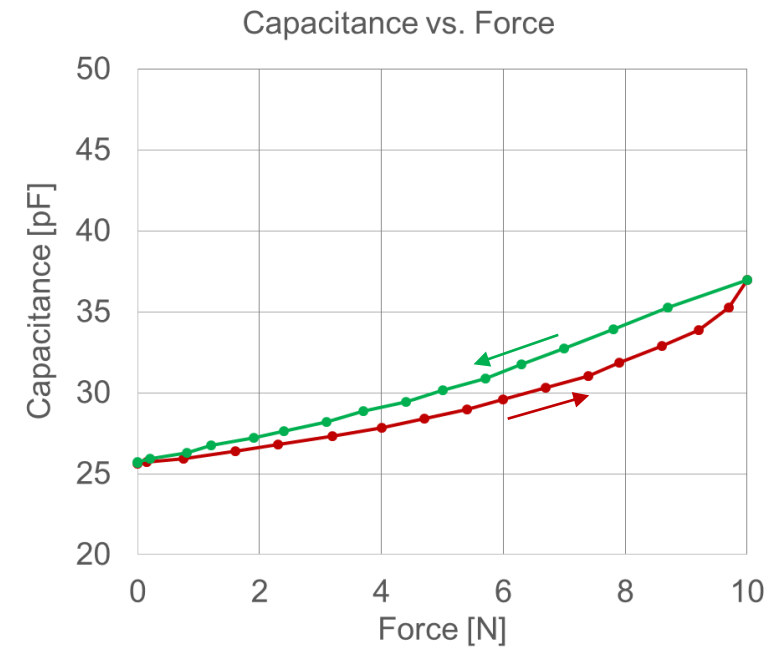
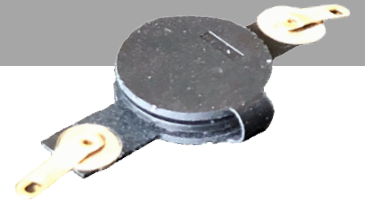
Performance

Linearity

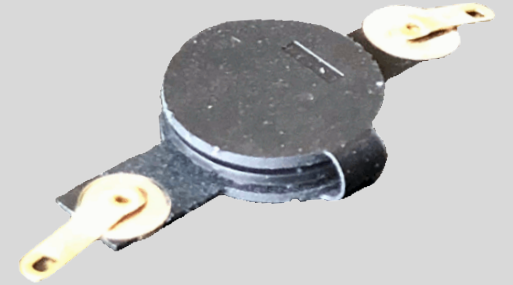
Sample lot



Hysteresis



Use Case: Automotive HMI

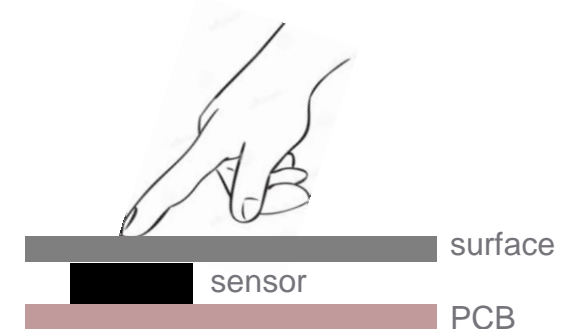


Safe touch interaction

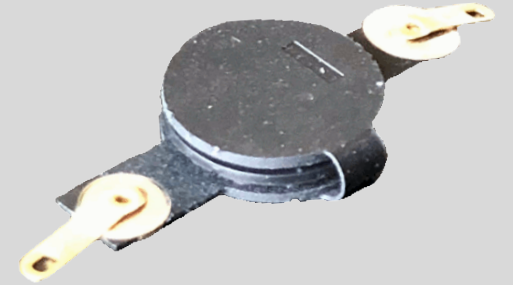
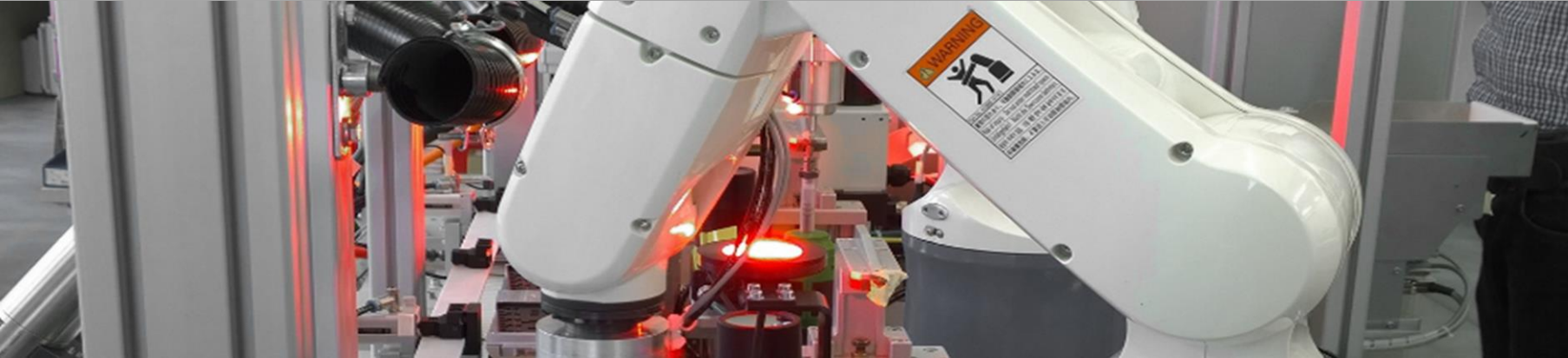
- Force sensor ensures unintended user actuation by touch
- Soft structure compensates assembly tolerances (unlike e.g. rigid force-sensitive resistors foils).

Specifications (can be tailored):

Type: capacitive
Size: dia. 15 mm
Thickness: 4.0 mm
Force: 0...20 N
Signal (fs) >10pF

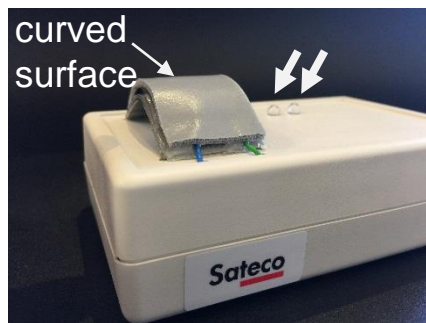


Use Case: Collaborative Robotics



Collision detection and prevention

Idle



Dark LEDs

Touch (proximity)



Blue LED is "on"

Light pressure



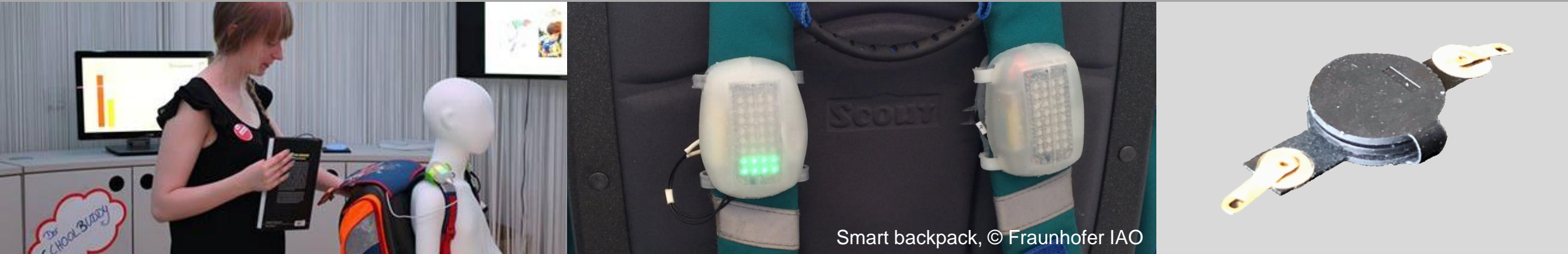
Green LED is weak

Strong pressure



Green LED is bright

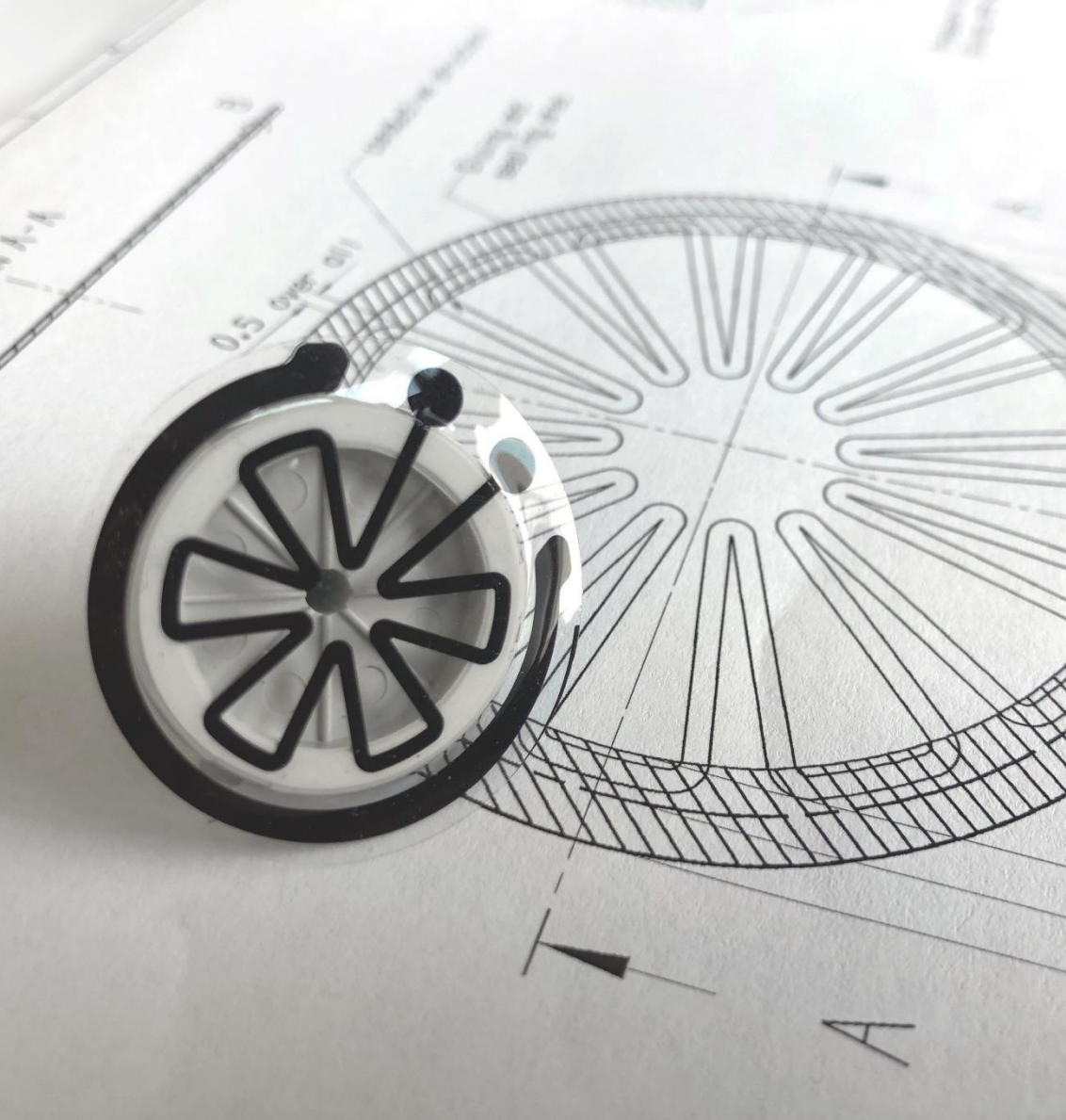
Use Case: Wearables



Safe fastening and loading

- feasibility project with **Fraunhofer Institute for Work and Health Safety, Germany**
- Further potential: exoskeletons (manual teaching, rehabilitation)
- point-of-care devices and textiles (smart bandage, sleep monitoring mattress,...)
- ...

OEM Projects



Intelligent elastic structures

Silicone:

- High mechanical durability (>100,000 load cycles)
- Excellent elasticity
- High temperature (-40 ... 200°C)
- Optical translucency
- Skin-friendly

Process:

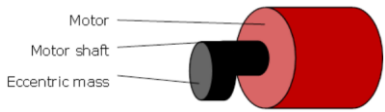
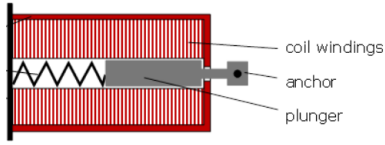
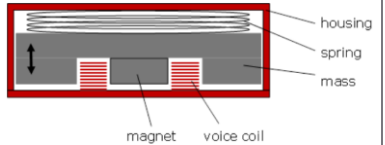
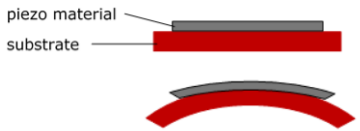
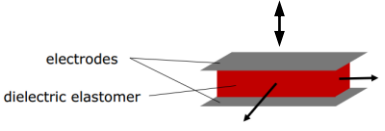
- 3D molding
- Coating
- Passivation



Silicone Actuator

- Silent artificial muscle
- High force
- Large displacement

Actuator Technologies

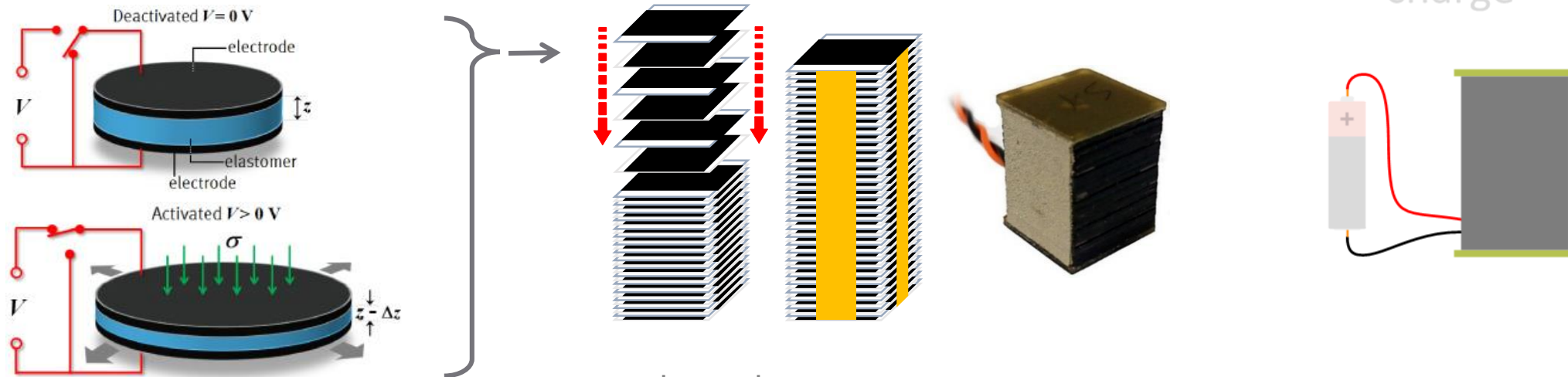
	Eccentric Rotating Mass (ERM) 	Solenoid Resonant Actuator (SRA) 	Linear Resonant Actuator (LRA) 	Piezo 	Silicone Transducer 
Actuator type	vibration only	pulse & vibration	pulse & vibration	pulse & vibration	pulse & vibration
High-definition haptics	No	No	Yes for wideband (LWA)	Yes for amplified piezo	Yes
Localized actuation	No	No	No	Yes	Yes
Noise	Yes	No	No	Yes	No
Rise time	40-80 ms	5-10 ms	1-30 ms	1 ms	2-5 ms
Force	-	-	-	2...20 N	2...10 N
Stroke	-	-	-	max. 0.2 mm	0.2...0.7 mm
Maturity	Mature	Mature	Mature	Mature / Emerging	Emerging

Unique combination

Silicone Actuator

Unique technology: high force and large displacement


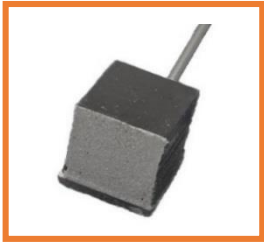

Electrical power transforms into mechanical motion by elastic deformation



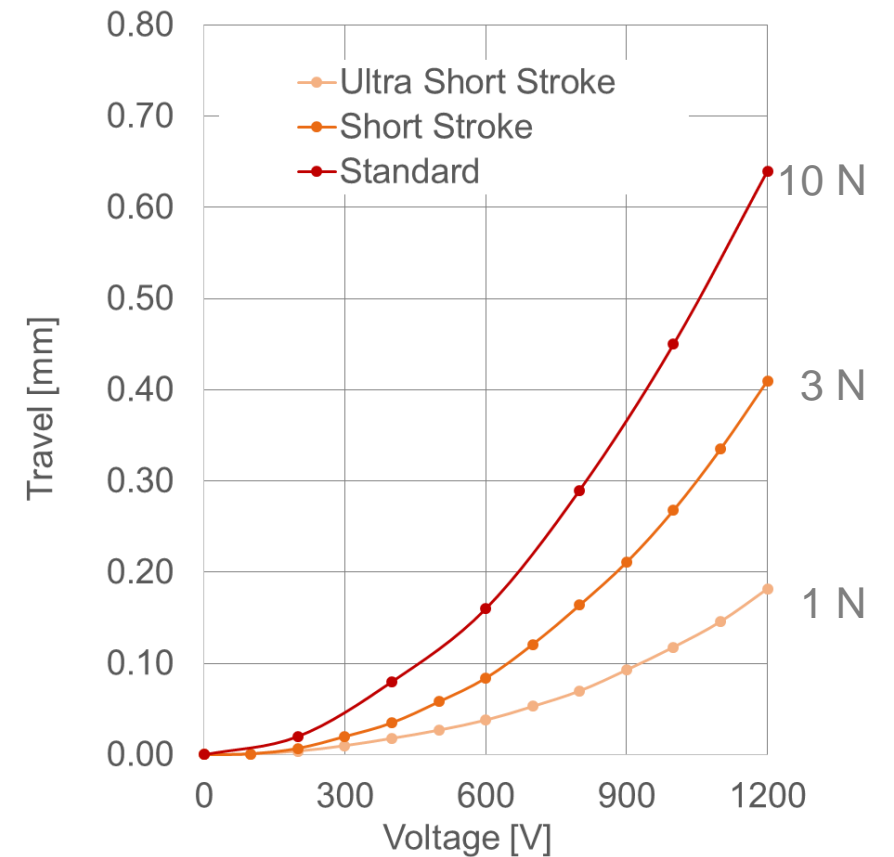
- low noise,
- maintains specific position without using power,
- durable (>10M cycles),
- operating range -40°C to $+85^{\circ}\text{C}$.

Performance

Kinematic performance of silicone transducer

	Ultra Short Stroke	Short Stroke	Standard	
				
Footprint *	10 x 10	10 x 10	15 x 15	mm ²
Height *	5	10	20	mm
Max. Stroke	0.18	0.40	0.65	mm
Max. Force	1	3	10	N

* various custom-tailored shapes possible



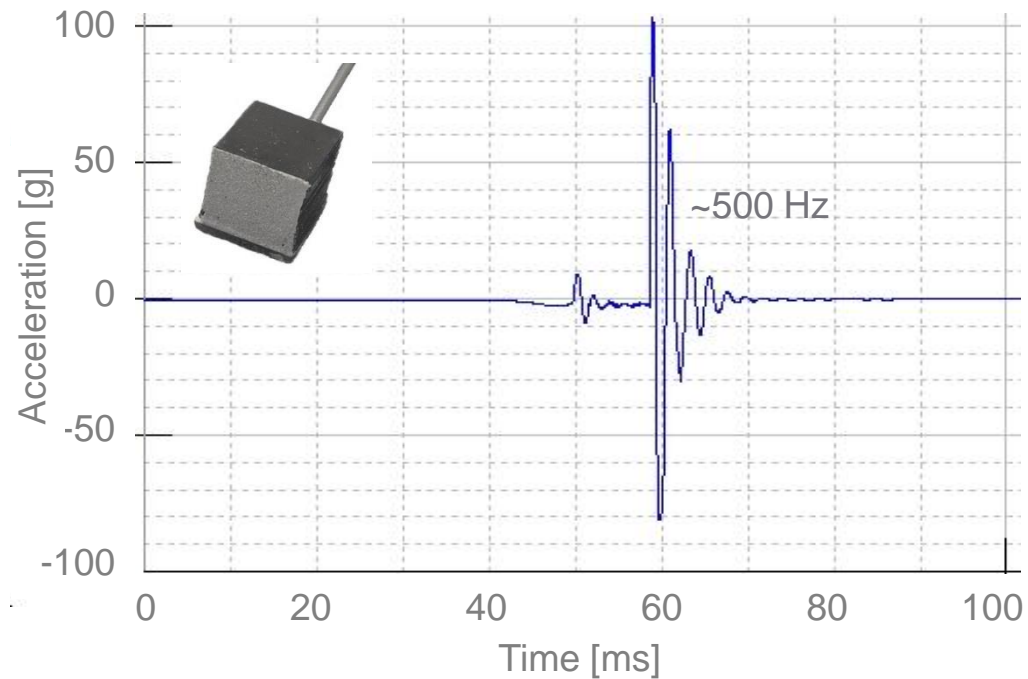
Performance

Impulse performance of silicone transducer

Short Stroke Transducer

Area: 10 x 10 mm

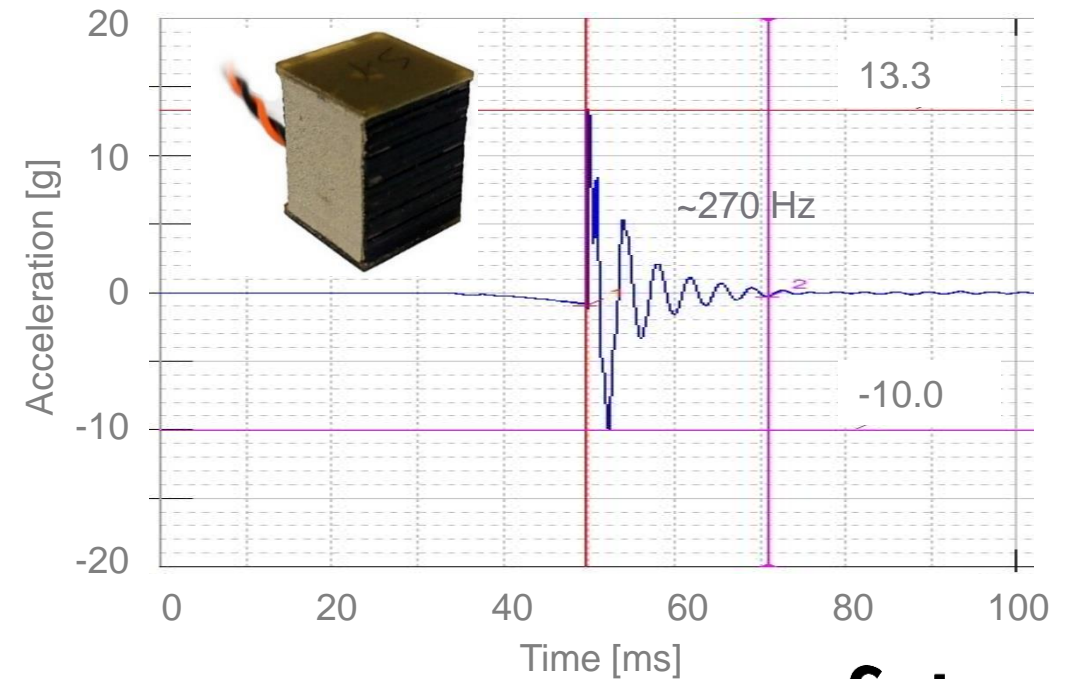
Height: 10 mm



Standard Transducer

Area: 15 x 15 mm

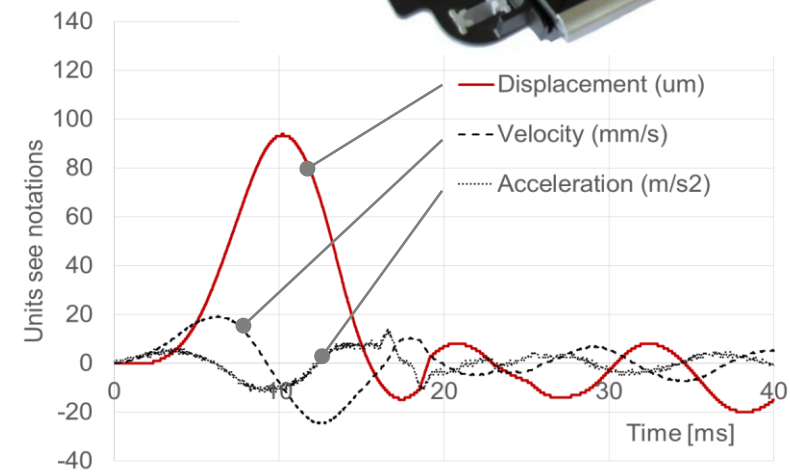
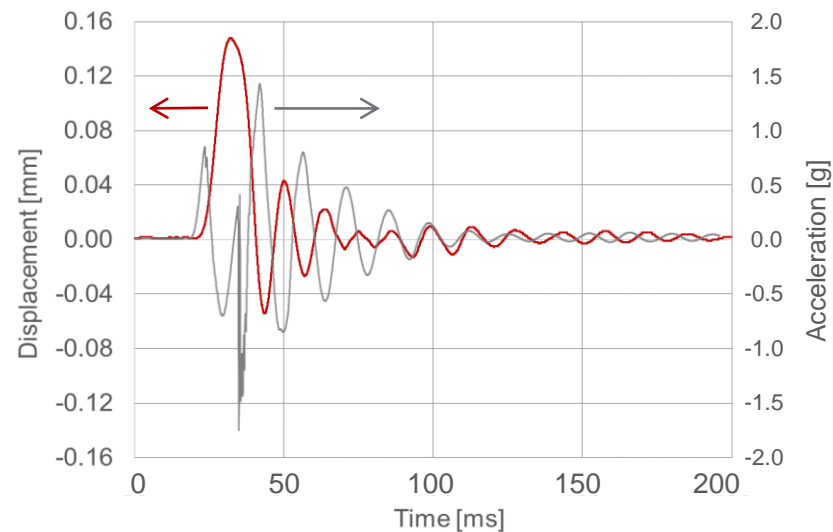
Height: 20 mm



Use Case: Automotive HMI

Touchpad with active feedback

Single pulse (<20ms)



- Demonstrated system performance close to OEM target specification

Further Potential



Use Case

- Shape changing surface,
- Immersive acoustic stimulation,
- Smart sealing (adaptive sealing pressure,...)
- Fluid control (valve, micro-dosing,...)
- ...

