Inspection technology for quality control after cleaning and activation

Stefan Büttner

Applications

SITA Messtechnik GmbH

SITA Messtechnik GmbH

SITA Messtechnik – Advanced Cleaning Control

SITA Lab Solutions

- Tensiometer for measuring dynamic surface tension of liquids
- Foam tester for fully automated testing of foam characteristics

→ www.sita-lab.com

SITA Process Solutions

- Measuring surfactant concentration
- Inspecting part cleanliness
- Monitoring bath contamination

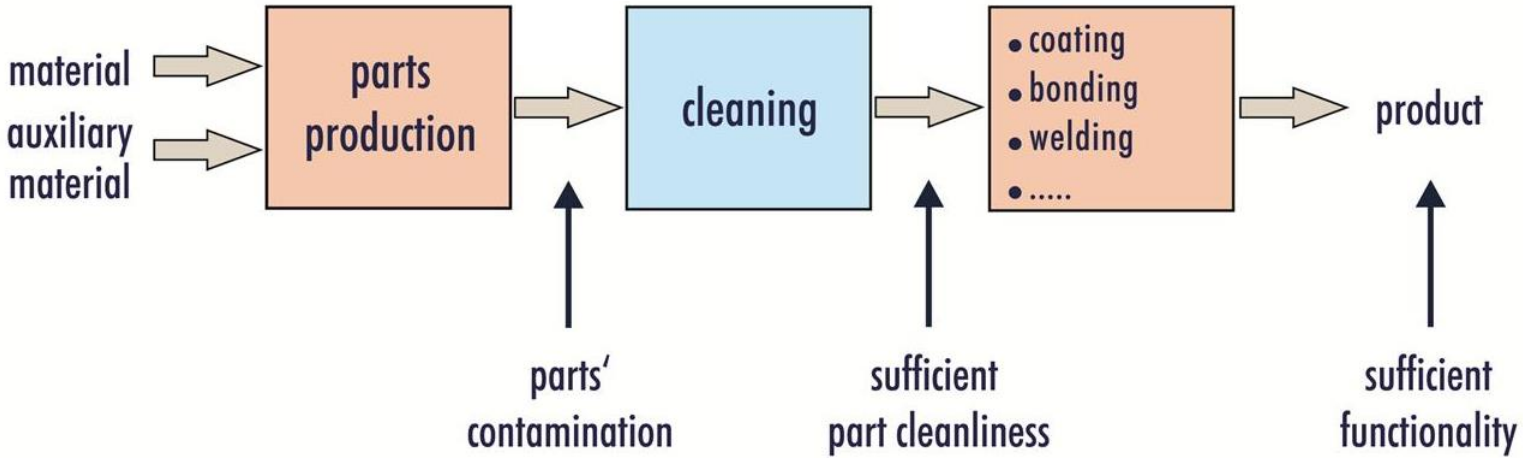
→ www.sita-process.com

SITA Messtechnik and SITA-Distributors

www.sita-lab.com

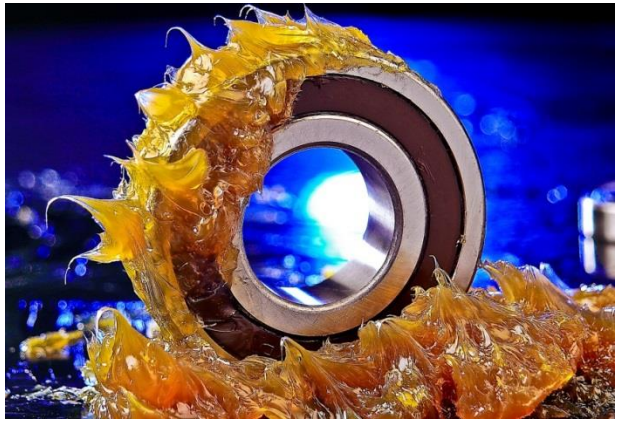
www.sita-process.com

Process chain – The source of filmic contamination



Source: Autobild

Filmic contamination in production processes



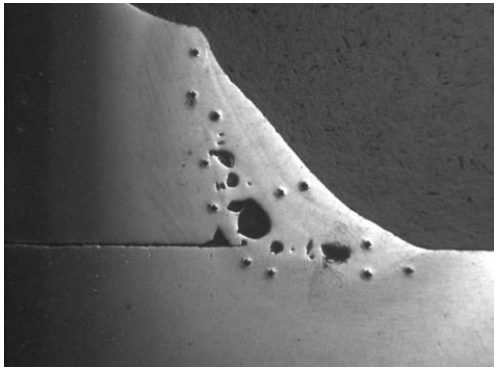
Cleanliness is crucial – Impact of filmic contamination

Poor adhesion when painting or bonding

Source: wwww.besserlackieren.de

Source: www.loctite.de

Pores in the weld seam



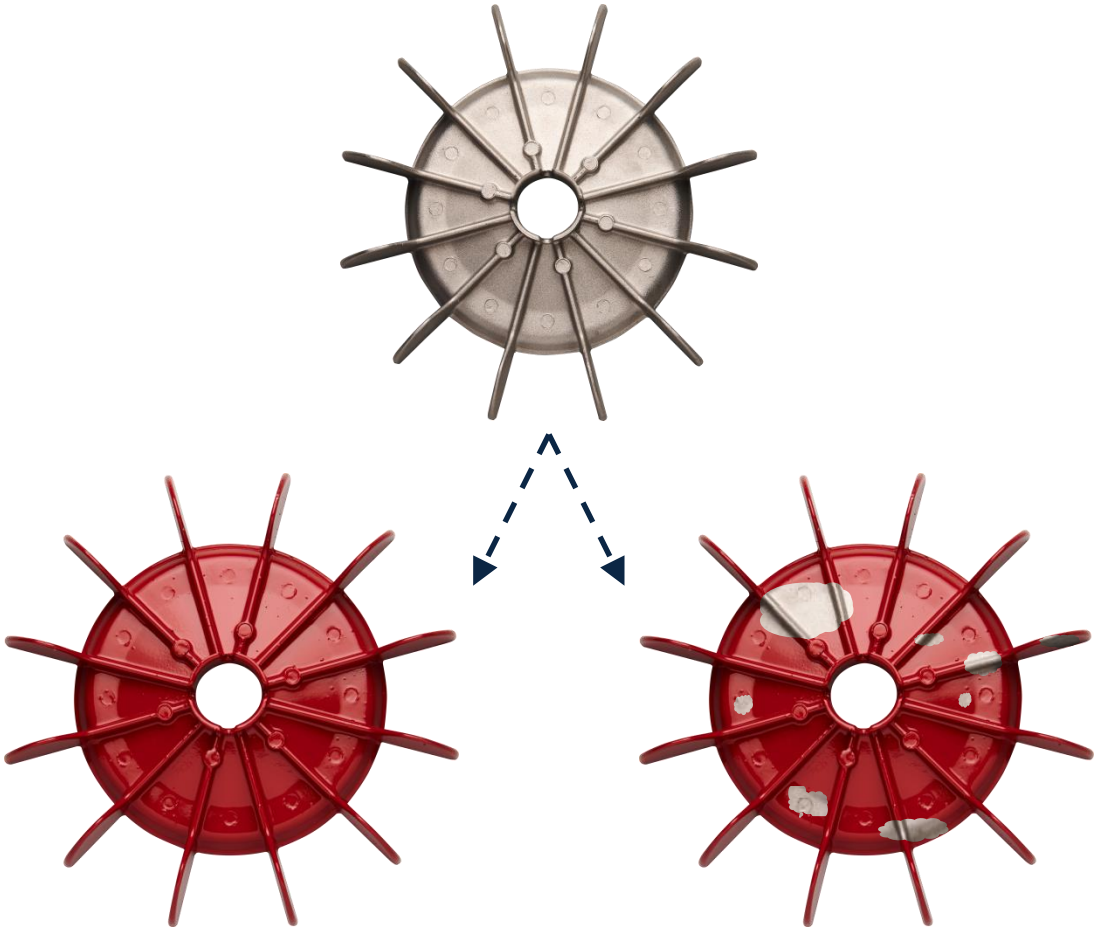
Source: www.profabricationtechniques.com

Further examples

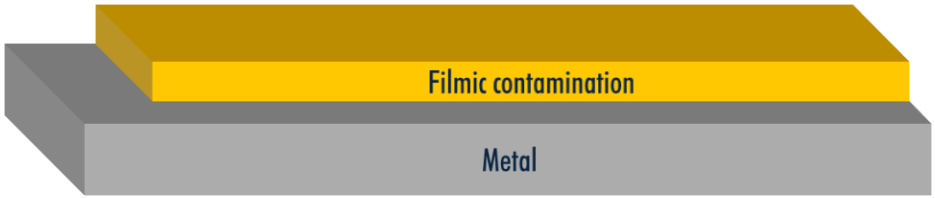
- Soft spot formation in gas nitriding processes
- Defects in coating (electroplating, PVD, CVD)
- Bad electrical contact when soldering or bonding

Task of cleanliness inspection

Clean enough for painting?



How to detect filmic contamination



Taking advantage of the properties of a contamination:
Visual impression, wettability, fluorescence, elemental composition, …

Common techniques
→ FiT-Guideline „Filmic contamination in control“
(Fachverband industrielle Teilereinigung e.V.)

For process control
- Visual inspection
- Wipe test
- Water break test
- Dyne test inks
- Contact angle measurement
- Fluorescence measurement

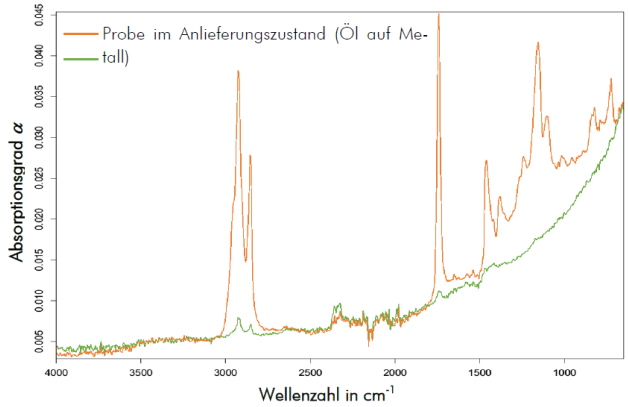
Laboratory/for analysis
- TOC
- IR-Spectroscopy
- REM/EDX,
- XPS
- ToF-SIMS
- GC-MS, Residual gas analysis

Laboratory analytics unsuitable for easy cleanliness inspection

Application analytical methods and methods for process control

Analytics - Spectrometry

Source: Uni-Oldenburg



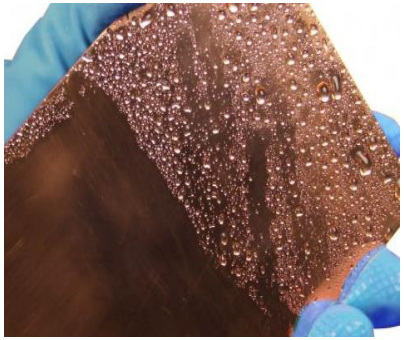
Process control - Fluorescence measurement

SITA

Contact angle measurement

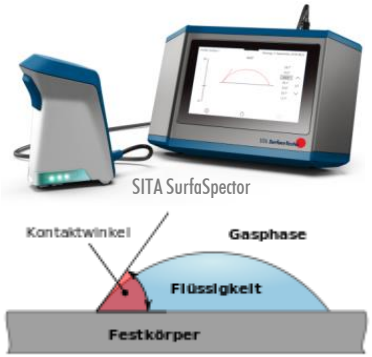
Method overview: techniques for testing wetting behaviour

	Water break test	Dyne test inks	Contact angle
Invest:	low	low	medium
User impact	subjective	subjective	objective
Value:	no	yes	yes
Remark:		can be poisonous (consider H&S), comparability only with same ink (manufacturer/formulation)	
General:	Wettability increases or decreases depending on kind of contamination or treatment		



Source: Heatcon.com

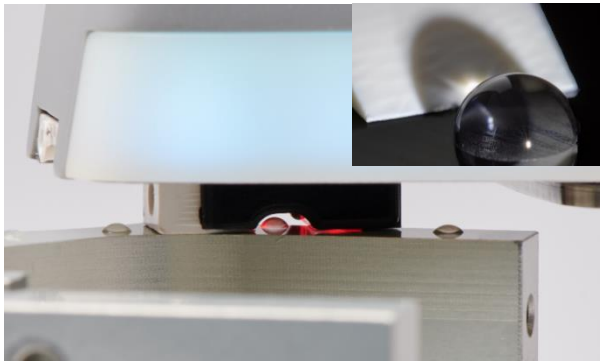
Source: Tigres information leaflet dyne test inks



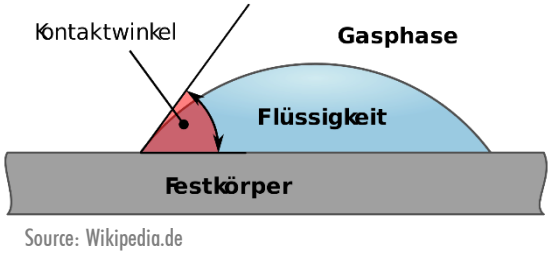
Source: Wikipedia

Measure contact angle – Test wetting behaviour

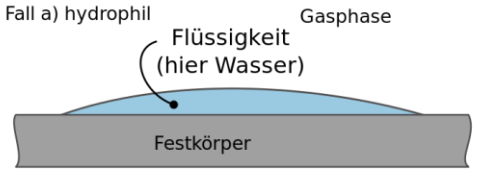
SITA SurfaSpector

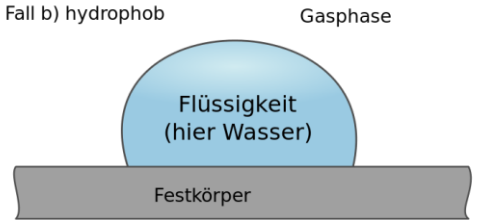


SITA SurfaSpector



Source: Wikipedia.de



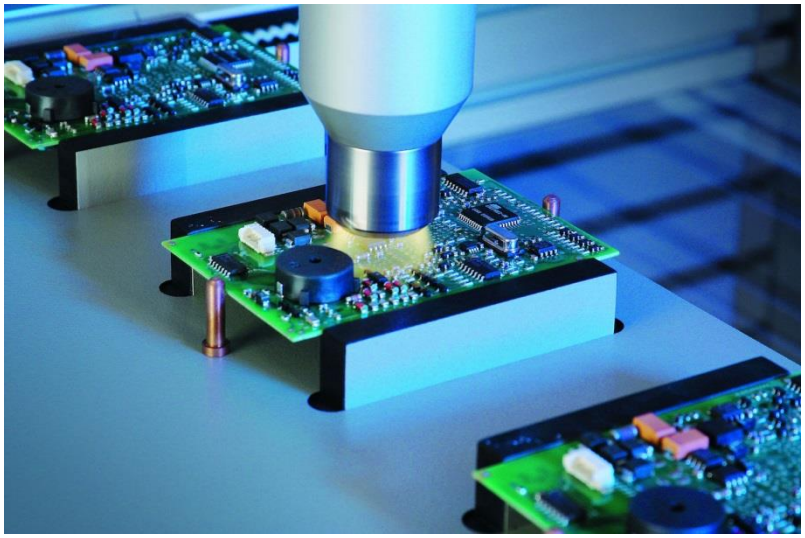


Source: Wikipedia.de

- Mobile measurement of water contact angle
- Patented method – robust on glossy surfaces, easy handling on complex geometries
- Allows quality inspection directly in production environment

Application: **surface treatment monitoring** or **cleanliness inspection**

Application: Analysis and process control in electronics manufacturing



Example image
Source: Plasmatreat

Example image
Source: www.ilh.uni-stuttgart.de

Application: Process control in electronics production for electromobility

Starting point: Coating on printed circuit boards falls off during production

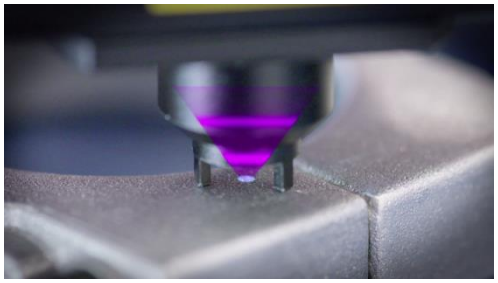
Solution:

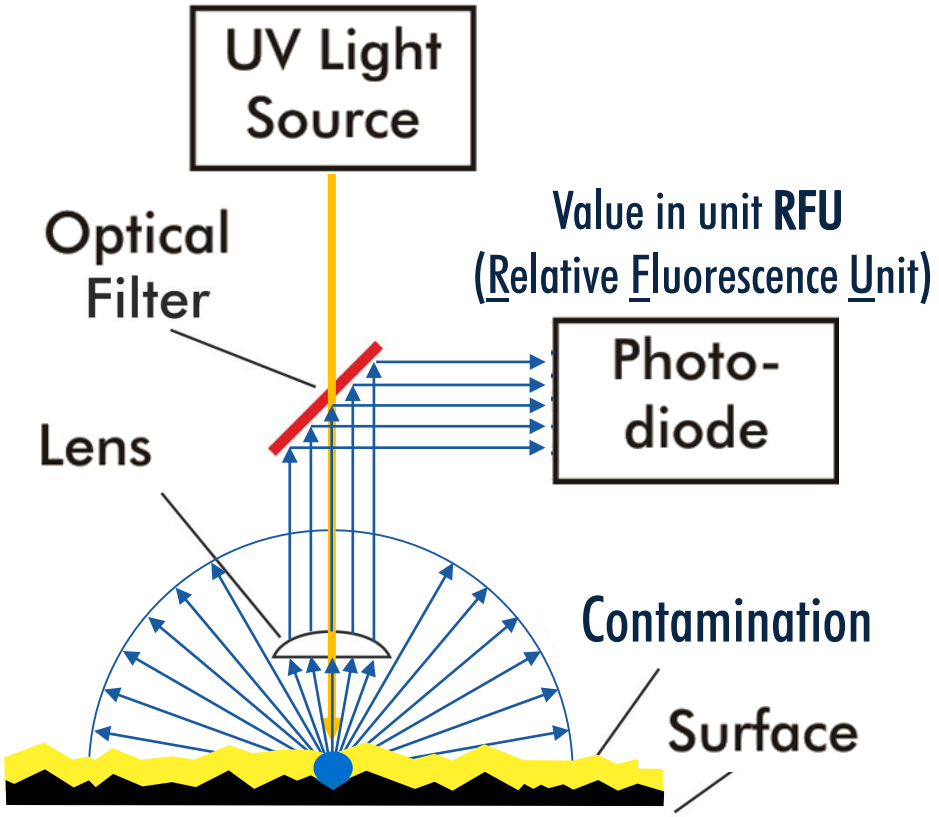
1. Laboratory analysis XPS: residues of fluoropolymer interfere with paint adhesion
2. Removal of fluorine residues by plasma cleaning
3. Contact angle measurement for process control of plasma cleaning

SITA

Fluorescence measurement

Measure fluorescence – Inspect cleanliness





- Fluorescence intensity measurement – Standardised with SITA Calibration Standard
- Detection of residual oil, grease, cooling lubricants, separating agents etc.

Application: **Cleanliness inspection** or **coating thickness inspection**

Measuring devices for cleanliness inspection

SITA *CleanoSpector*

Mobile measuring device for cleanliness inspection of parts

SITA *CLEAN LINE CI*

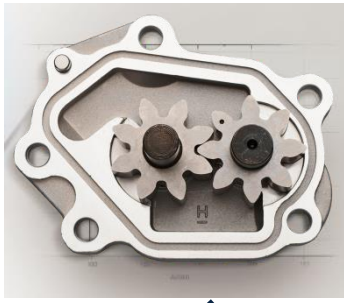
System solution for inline cleanliness control

SITA *FluoScan 3D*

Measuring/testing bench for automated cleanliness control

Correlation and defining limit values

Parts cleanliness



Connection ?

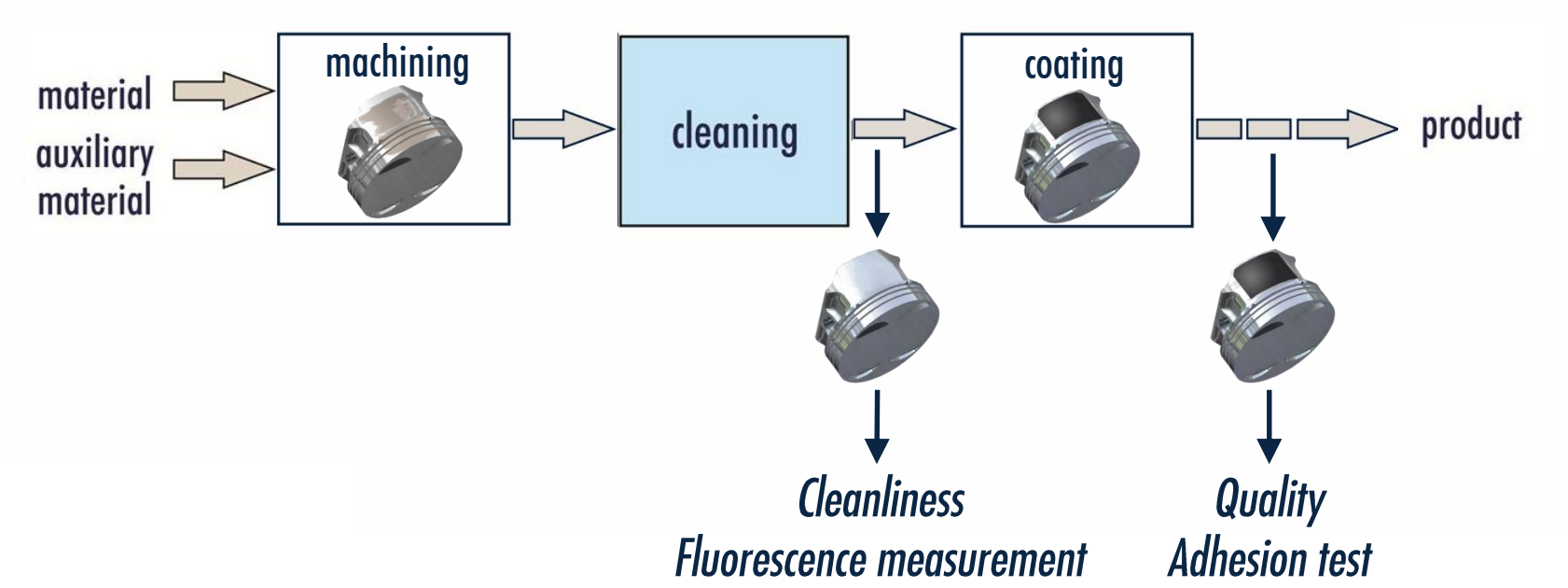
Impact

Source: www.loctite.de

Fluorescence measurement

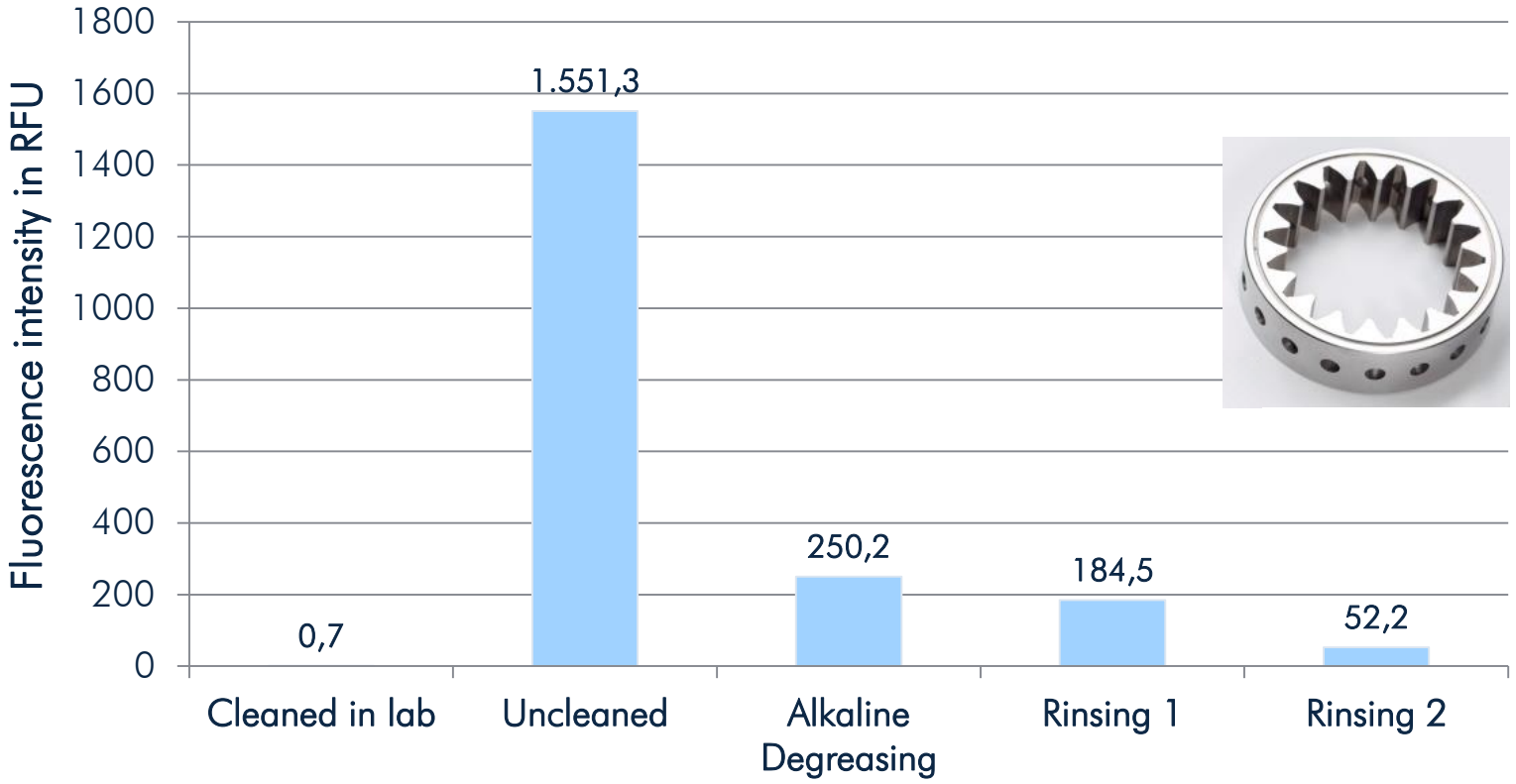
Correlation and defining limit values!

The limit value is set by the process



Application:	Anti-Friction-Coating of pistons
Starting Point:	Good adhesion requires high cleanliness
Defining limit values:	Correlation between fluorescence measurement and adhesion test

Application: Monitoring of cleaning process



Cleanliness in different steps of the cleaning process

Fluorescence measurement for monitoring, optimisation and control of cleaning processes

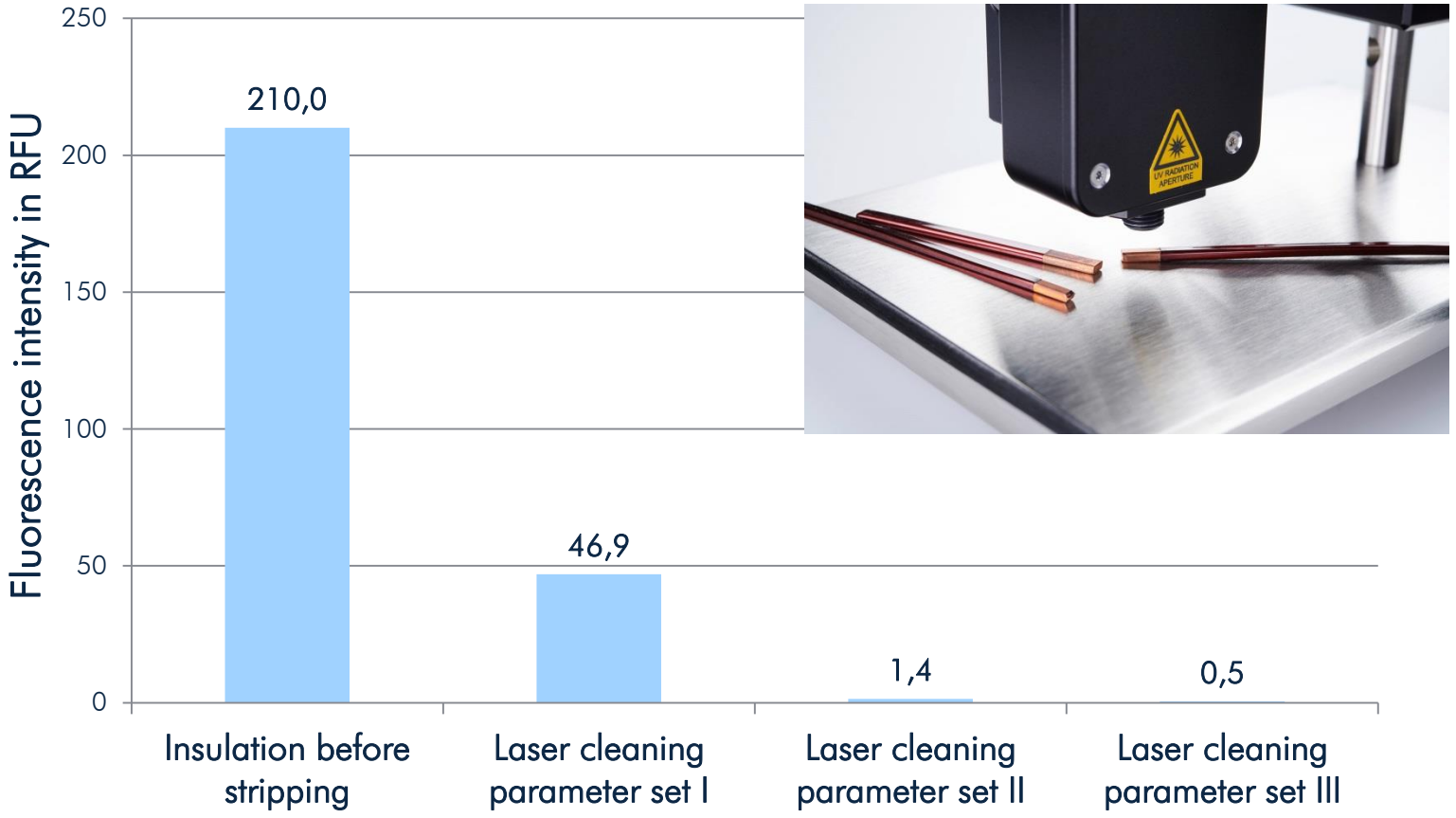
Application: Metal components for medical devices

- Machined components from stainless steel, brass, aluminium
- Contaminated with cooling lubricants (emulsion, oil)
- Comparison of different cleaning machines

Mean values of Cleanliness inspection by Fluorescence measurement

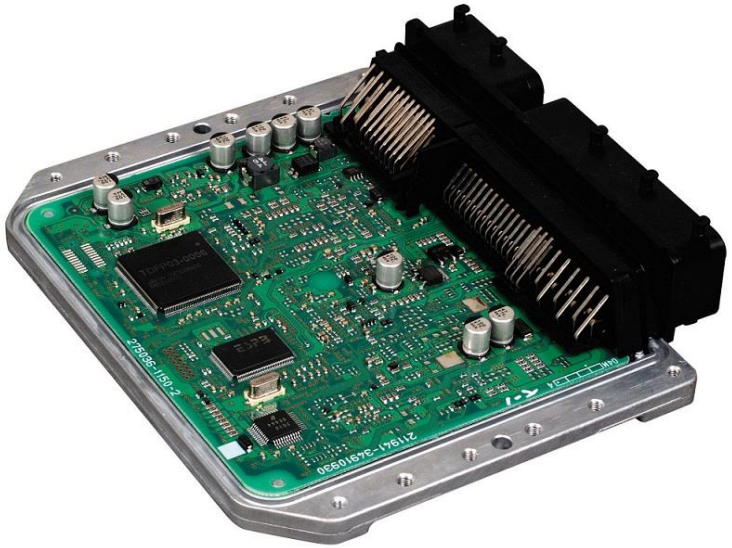
uncleaned	cleaning machine P	cleaning machine R-1	cleaning machine R-2	lab reference
601.8 RFU	7.9 RFU	1.4 RFU	2.7 RFU	0.8 RFU

Application: Design and optimization of cleaning processes

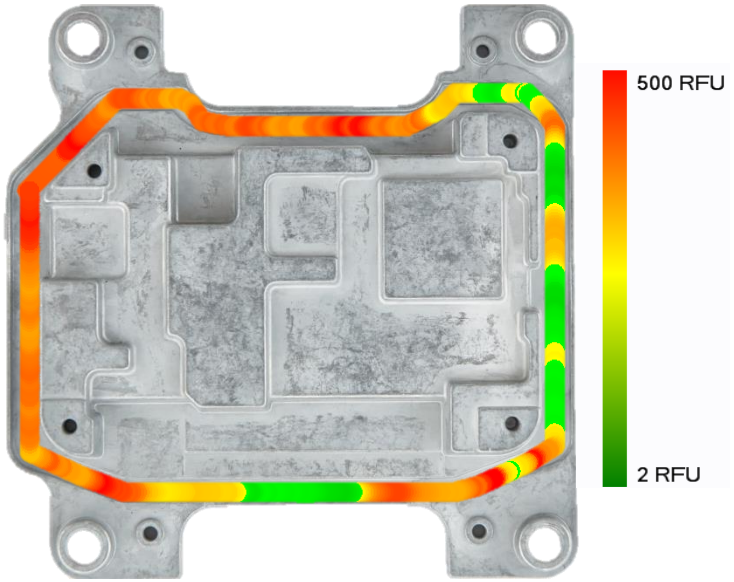


Application:	Technical design and optimization of a laser cleaning/stripping process
Starting point:	Process design with variation of laser cleaning parameters
Aim:	Optimization of cleaning effect with minimal cycle time/cleaning time

Application: Sealing of aluminum housings



Example Image
Source: www.denso-europe.com



Source: SITA Messtechnik

Application:	Sealing of aluminium housings protection electrical components (ECU)
Starting point:	Good adhesion requires high cleanliness
Problem:	Destructive testing in lab takes 3-5 days
Solution:	Cleanliness inspection of sealing groove using fluorescence measurement

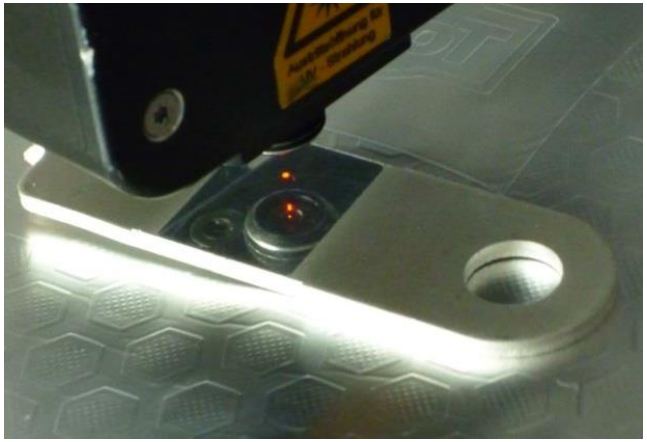
Application: Laser beam welding of gears parts

Example Image
Source: www.trumpf.com

Example Image
Source: http://www.lidag.ch/laserschweissen/

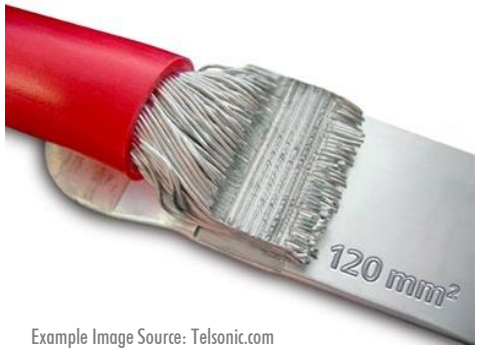
Starting Point:	Laser cleaning and laser welding of gear parts
Problem:	Filmic contamination leads to pores in the weld seam
Solution:	Inline cleanliness inspection of gears, monitoring effect of laser cleaning
Products:	Customers use SITA CleanoSpector or automated inspection with clean line CI

Application: Friction welding of electrical connectors



Example Image Source: All-electronics.com

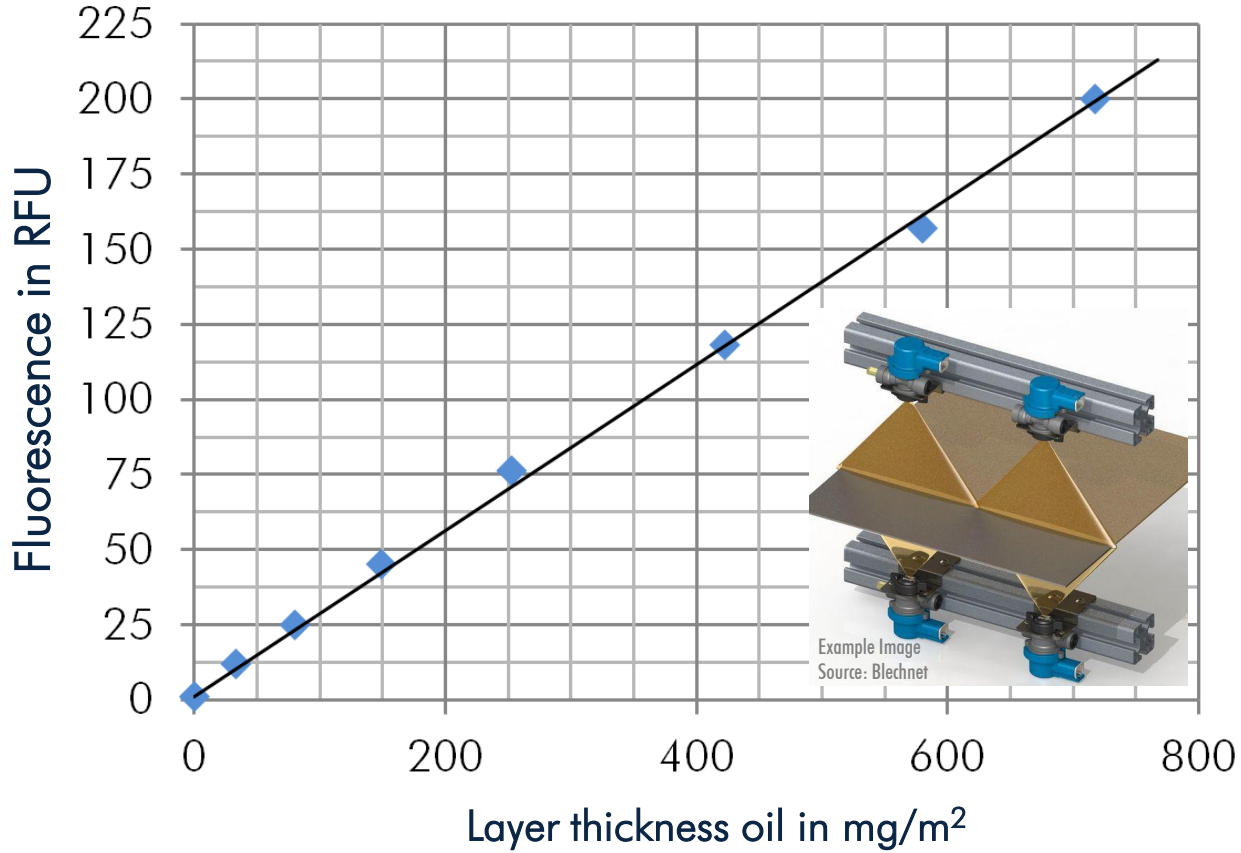
Example Image Source: Schunk Group



Example Image Source: Telsonic.com

Application:	Friction welding of electrical connectors
Problem:	Contamination (e.g. punching oil) reduces friction and impairs welding
Solution:	Cleanliness inspection with SITA CleanoSpector prior to welding

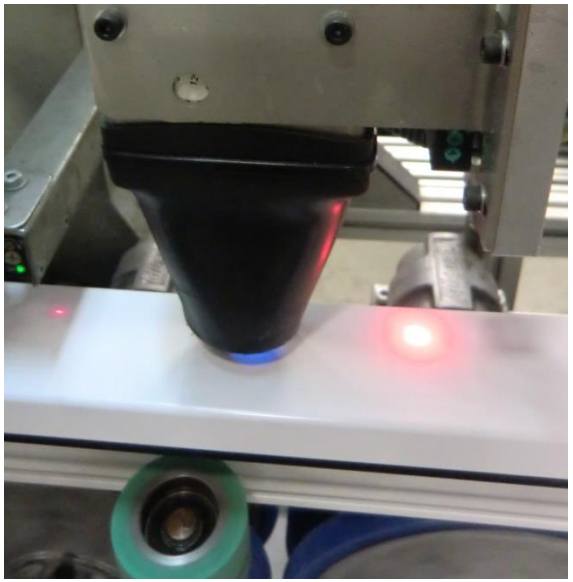
Application: Coating thickness inspection of anti-corrosion oil



Application:	Coating thickness inspection of anti-corrosion oil
Starting point:	Sufficient amount (layer thickness) is needed for sufficient protection
Solution:	Inspection using fluorescence measurement (amount, even distribution)

Application: In-line primer monitoring

Example Image
Source: fensterprofile.kleiberit.com



Source: SITA Messtechnik

Application:	Monitoring primer application on windows' frame PVC profiles prior to lamination with decor foil
Characteristics:	Inspection for sufficient amount, no primer and to much primer is a problem
Solution:	Inline inspection, strong fluorescence of primer SITA clean line CI with special optics

Characteristics

SITA - Fluorescence Measurement

Quantity	Fluorescence intensity in RFU
Application	**Cleanliness inspection** prior to gluing, painting, coating, welding, hardening, bonding, … **Coating thickness inspection** oil for rust prevention, primer application before gluing
Use	Detection of oil, grease, cooling lubricant, parting agents, … on parts and components made of metal, ceramics and glass (limited suitability for plastics)
Measurement	Contact free, non-destructive, in-line capable, thickness sensitive
Measurement monitoring	SITA Fluorescence standards (standard delivery and option)
Field	Automotive, machine construction, mechanical engineering, medical engineering, electrical engineering, surface engineering, air and space, …

Solutions for process control

Fact Sheet SITA Fluorescence Measurement

Optical method for detecting filmic organic contamination which fluoresce under UV light
Fluorescence signal increases with increasing film thickness/contamination quantity, but intensity also depends on type of organic material present
Detectable layer thickness ranges typical between 10 mg/m² to 10 g/m² (about 10 nm to 10 μm)
Fast, non-contact, non-destructive, inline-capable (measurement in motion)
Directly on part surfaces, spatial resolution, partial for functional surfaces
Confocal principle enables small (e.g. 1 mm wide) or complex test surfaces (e.g. strong curvature)
Requires accessibility of test surface and correct measuring distance
Suitable for non-fluorescent materials such as all metals and some ceramics, suitable for glasses and plastics only in individual cases
Low influence of surface roughness and structure (robust measurement)

Fact Sheet Contact Angle Measurement

Optical determination of the contact angle of drops of test liquids deposited on the surface as a measure of wettability

Wettability increases with decreasing contact angle (spreading drop)

Contamination-free, well wettable surfaces are more reactive

Wettability is sensitive to changes in surface condition:

- Wetting inhibiting and promoting substances (oil/release agents, surfactants),
- Oxidation and adsorption layers by reaction e.g. with the atmosphere
- Chemical or physical activation/passivation

Ultrapure water as test liquid reproduces this, is residue-free and non-toxic.

Water wettability depends on material: clean plastics without treatment have a poor wettability, clean metals without reaction layers have a high wettability

Differentiation only up to a few monolayers (up to several nm), no differentiation of thicker layers

Directly on part surfaces, spatial resolution, partial for functional surfaces

Surface roughness influences contact angle, directional structures (scoring, edges) have an effect

Common drop sizes in the microliter range require test surfaces several millimeters wide

Free surface energy can be correctly calculated only for non-contaminated surfaces and with at least two test liquids