HONG KONG ASIAWORLD-EXPO 亞洲國際博覽館

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Investigating Surgical Instrument Damage: How to ensure your investment is protected

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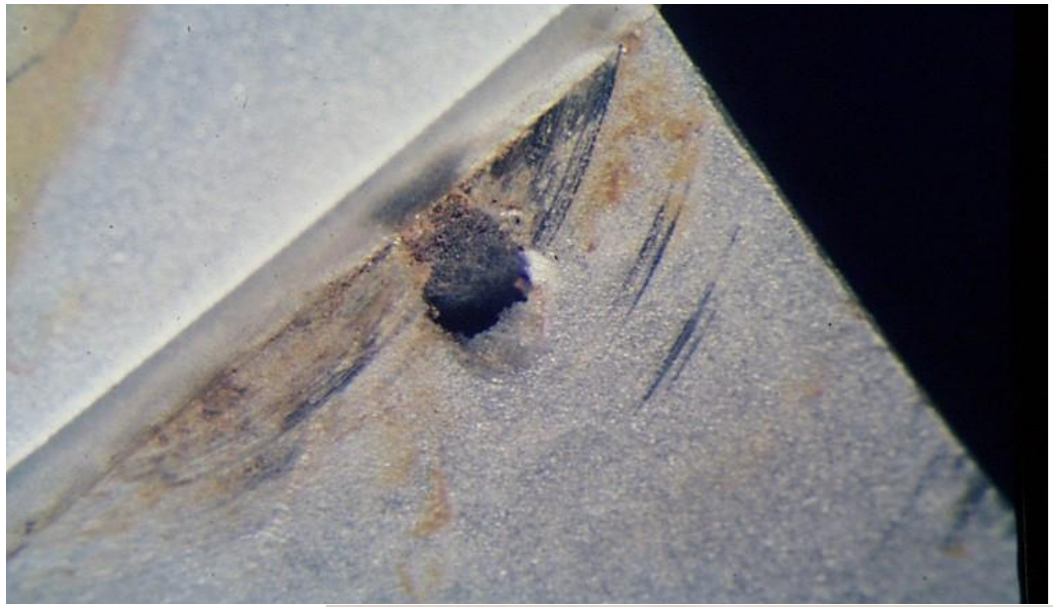
Topics

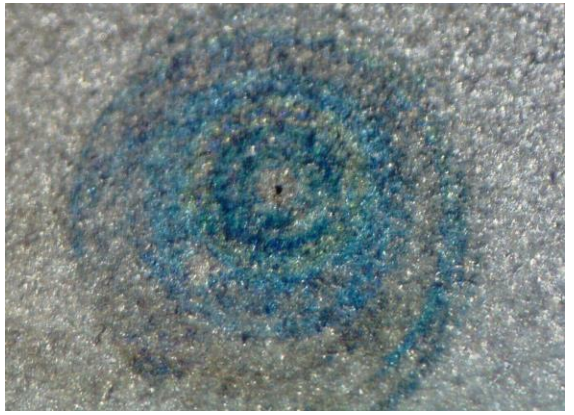
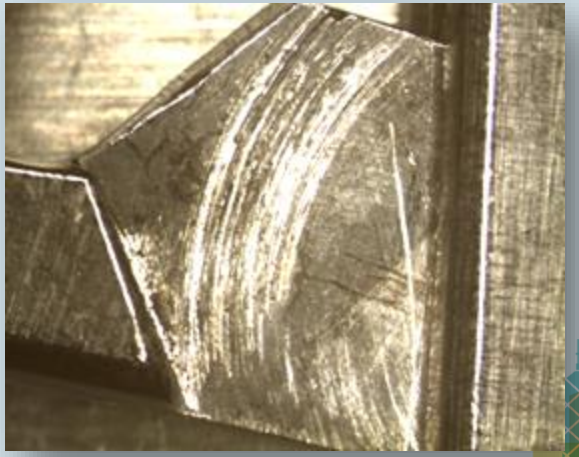
- Types of corrosion
- Instrument damage by corrosion
- Common causes and influencing factors
- Examples from praxis, prevention and correction

Types of corrosion



- Pitting corrosion
- Wear / fretting corrosion
- Stress corrosion
- Foreign and flash rust / secondary rust
- Crevice corrosion
- Surface corrosion
- Contact corrosion

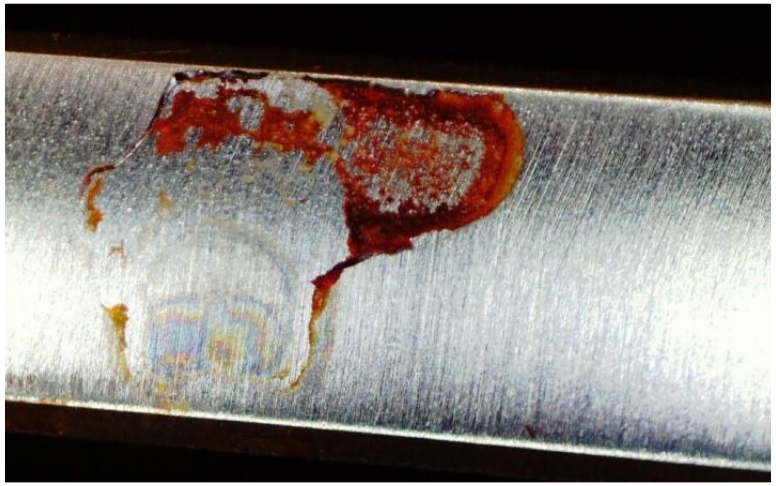
Most common types of corrosion

Type of corrosion, appearance		Reason and influencing factors	
Pitting corrosion	Pinhole like black points with rainbow colored surrounding or rust	Chlorides, moisture, temperature, time, Material	
Wear / fretting corrosion	Scoring and scratches, most in joints	Construction, insufficient care with oil, Material	

Most common types of corrosion

Type of corrosion, appearance		Reason and influencing factors
Stress corrosion	Stress cracking and fractures, often on joints or proximal end of forceps	Material stresses, material, temperature, chlorides 
Foreign or flash rust / secondary rust	Spot like up to uniform brownish discoloration	Processing unalloyed steels and / or corroded steels, water rust contaminated
Crevice corrosion	Rust within cavities	Medium, temperature, time, gap width, material
Surface corrosion	Uniform discoloration	Medium, temperature, time, material
Contact corrosion	Spot like brownish discoloration	Medium, different materials in contact

Pitting corrosion

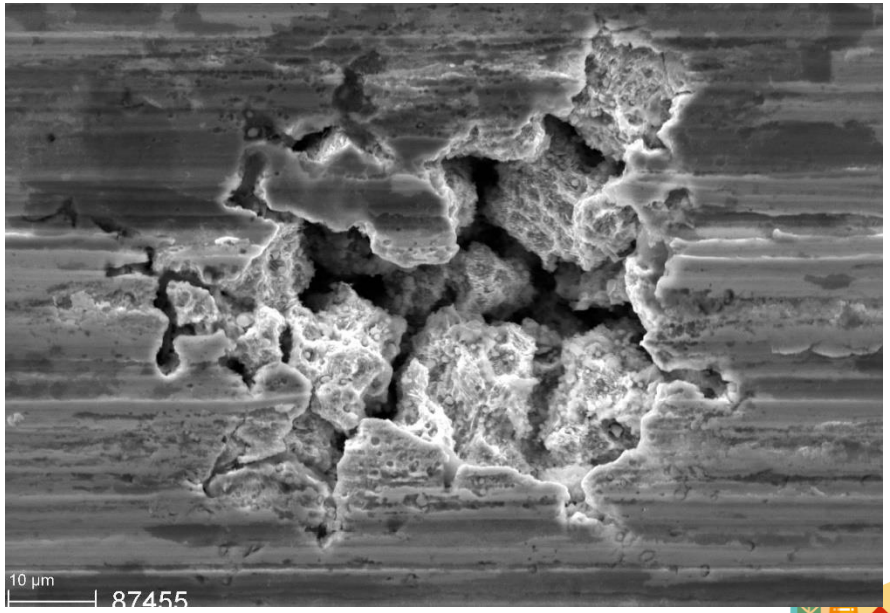


Action mode:

- Halides esp. chlorides penetrate the passive layer of stainless steel
- Corrosion starts within minutes

Sources:

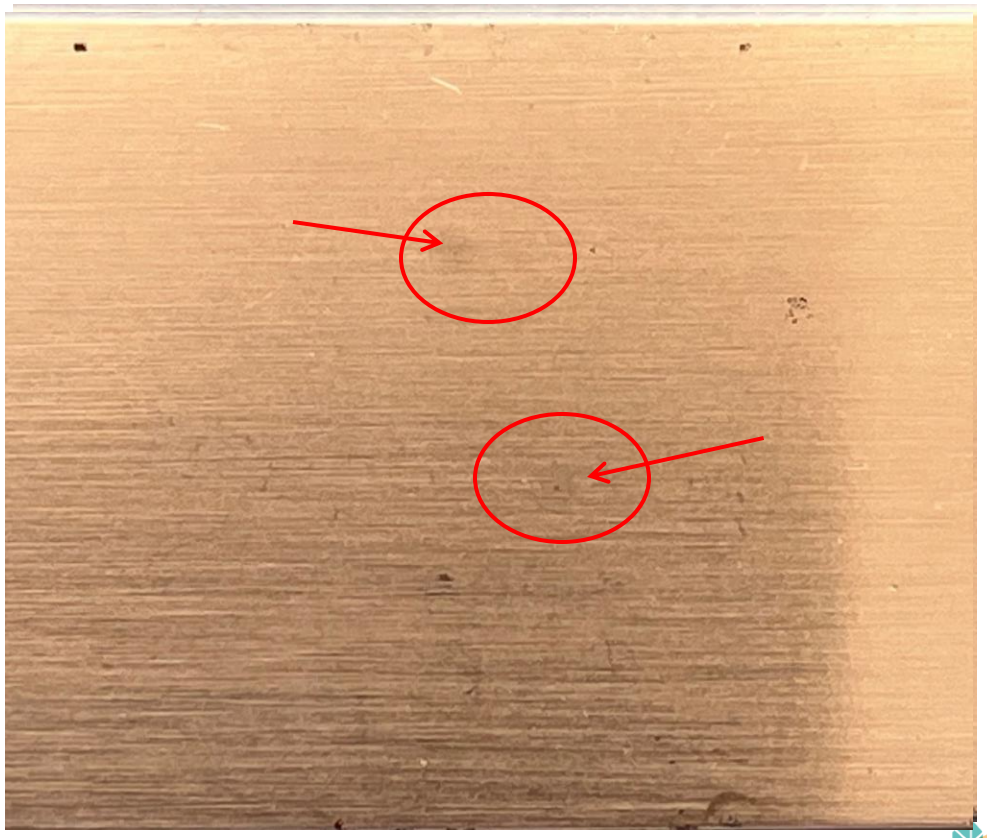
- Isotonic solution (i.e. physiologic saline)
- Blood, saliva, and secretion
- Water for processing



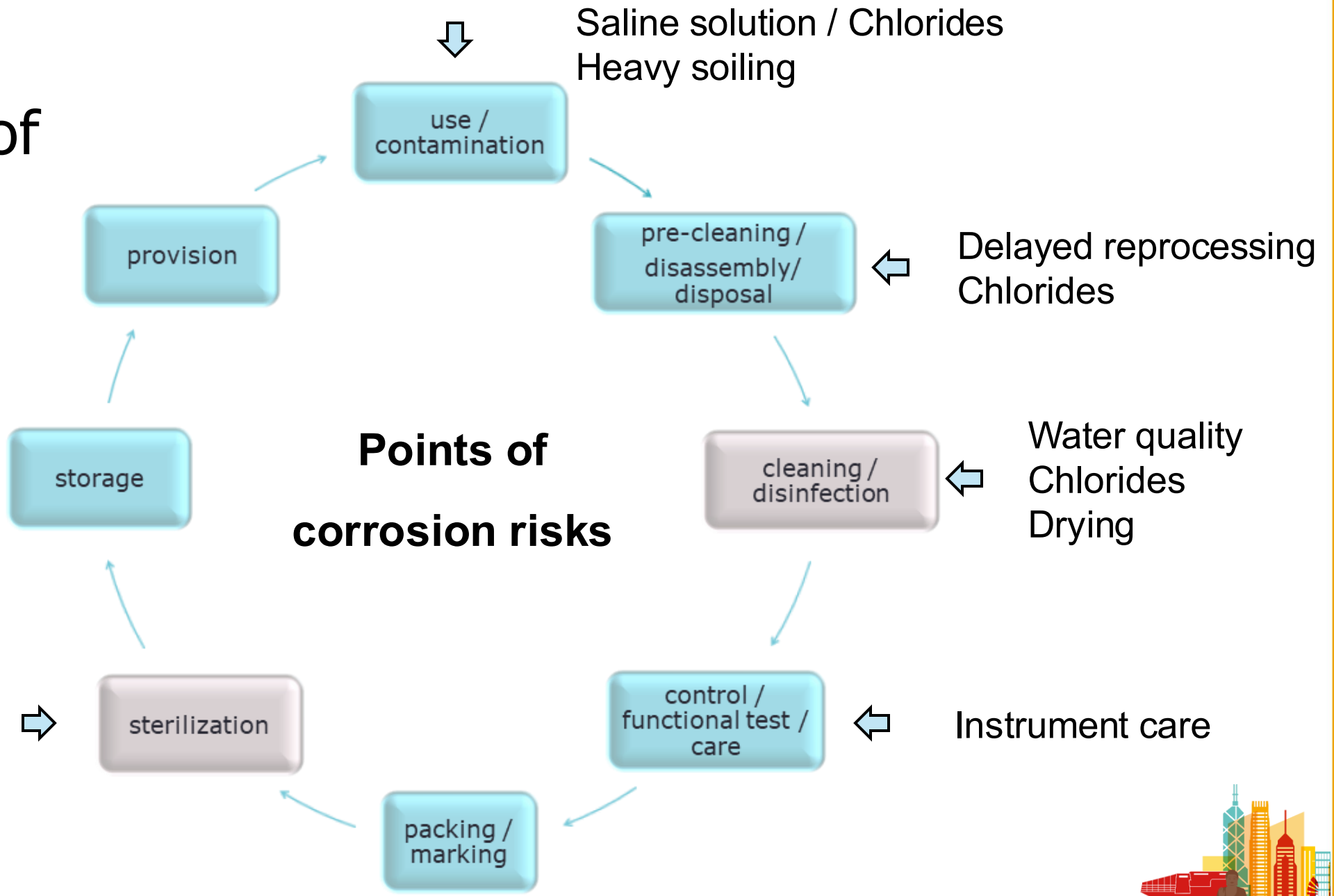
Influencing factors:

- Temperature
- Time / delayed reprocessing

Pitting corrosion



Circulation of instruments



Test of chloride resistance

Dr. Gerhard Kirmse
Surface changes - causes, consequences, solutions: Presentation at German Society Sterile Material Supply, 2015

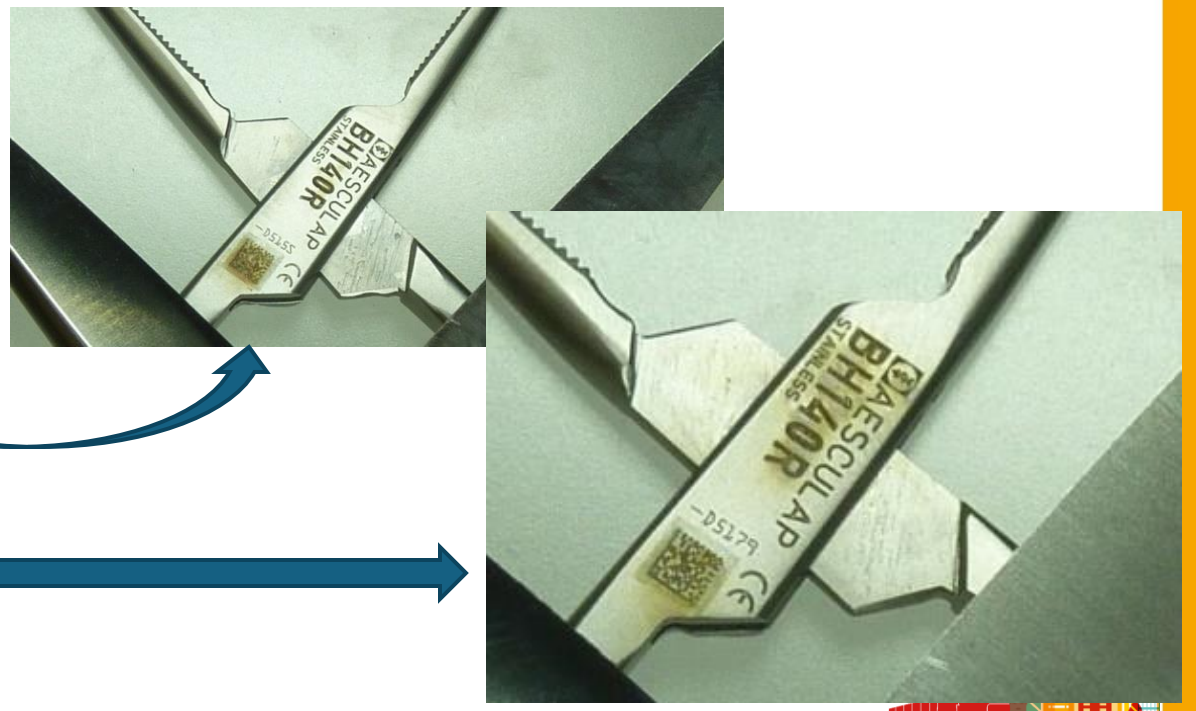
ISO 13402:1995 - Surgical and dental hand instruments — Determination of resistance against autoclaving, corrosion and thermal exposure

Test of stainless-steel instruments

- 2 – 100 mg/l chloride
- Boiling water (thermal disinfection)

Results

- 20 mg/l chloride visible signs of corrosion
- 100 mg/L chloride – clear corrosion of instruments



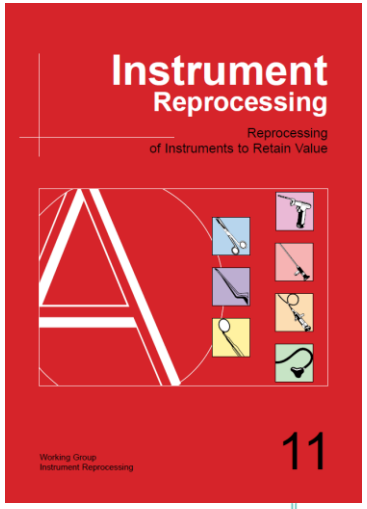
Water for the processing of medical devices

Washer Disinfector

- Tap water (utility water)
- Softened water (utility water)
- Deionised water (critical water)

ANSI/AAMI ST108:2023 Water for the processing of medical devices

Working group for instrument reprocessing (AKI), www.a-k-i.org



Steam Sterilizer

- Deionised water

ANSI/AAMI ST108:2023

Working group for instrument reprocessing (AKI), www.a-k-i.org

EN 285:2015 (A1:2021) Steam sterilizers – Large sterilizers

Recommended Water Qualities

Flushing / Washing / Rinsing:

Softened Water (Utility Water)

	AAMI ST108	AKI (www.a-k-i.org)
Appearance	Colorless, clear, without sediment	Colourless, clear
pH-value	6.5 – 9.5	5 – 8
Total hardness	< 150 mg $CaCO_3$/l	< 53 mg $CaCO_3$/l (3 °d)
Chlorides	< 250 mg/l	≤ 100 mg/l
Evaporation residue		≤ 500 mg/l
Conductivity	≤ 500 µS/cm	

Recommended Water Qualities

Final Rinse: Deionized water (Critical water)

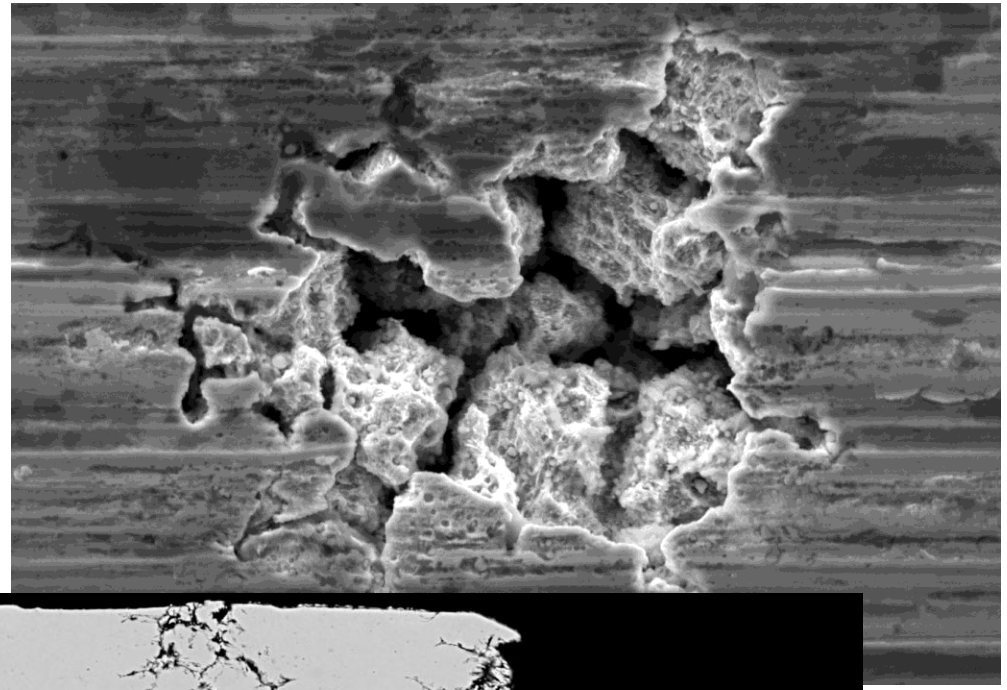
	AAMI ST108	AKI (www.a-k-i.org)
Appearance	Colourless, clear, without sediment	Colourless, clear, without sediment
Conductivity	< 10 µS/cm	≤ 15 µS/cm
pH-value	5 – 7.5	5 – 7.5
Water hardness	< 1 mg $CaCO_3$/l	≤ 2 mg $CaCO_3$/l (0.02 mmol/l CaO)
Evaporation residue		≤ 10 mg/l
Chlorides	**< 0.1 mg/l**	**≤ 0.5 mg/l**
Silicates (SiO_2)	< 1 mg/l	≤ 1 mg/l
Phosphate (P_2O_5)	< 1 mg/l	≤ 0.5 mg/l

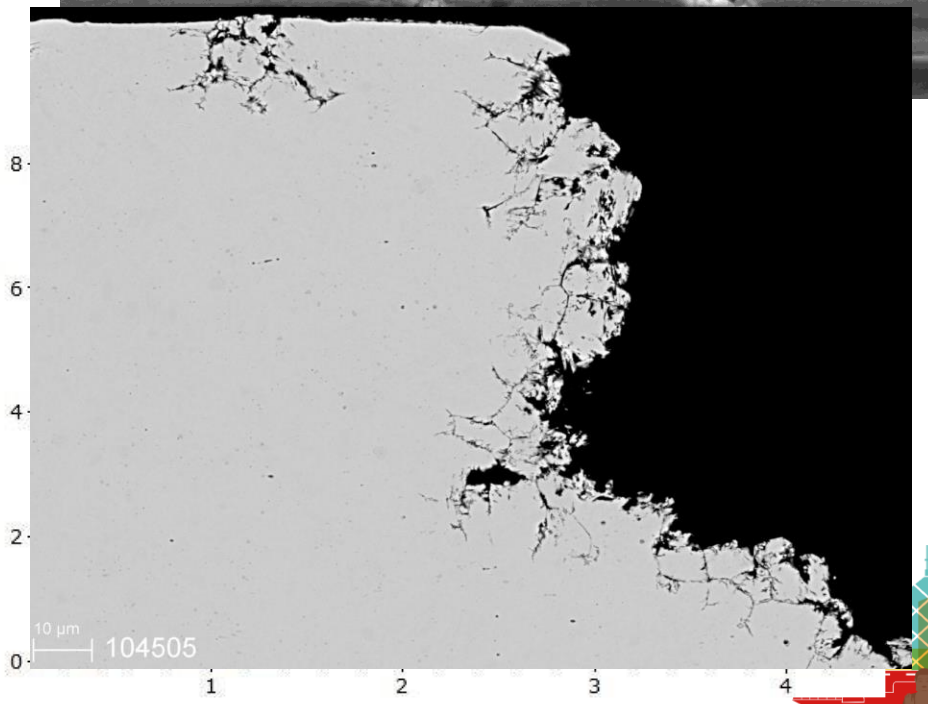
Corrosion under the microscope

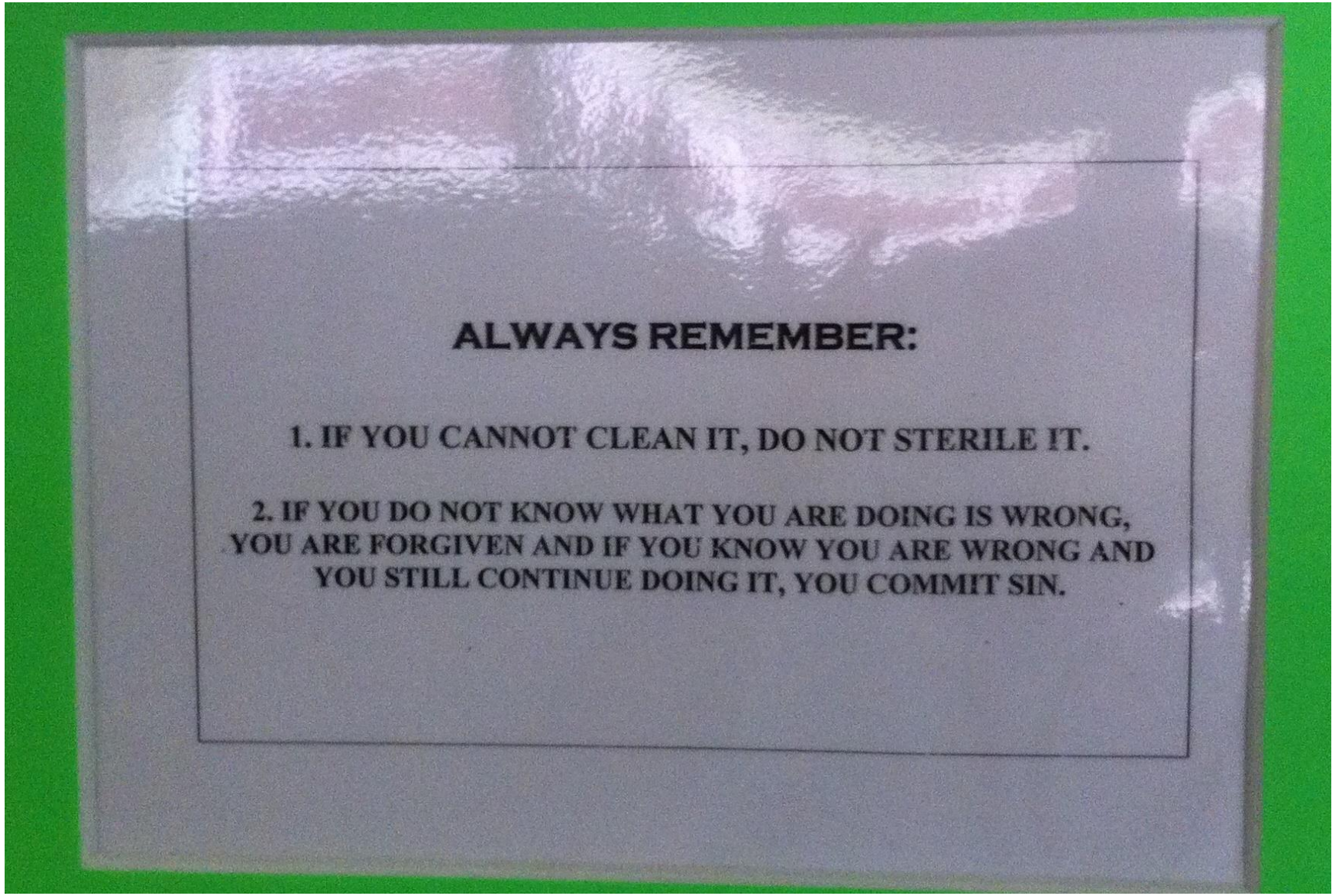
Risks from corrosion and instrument damage

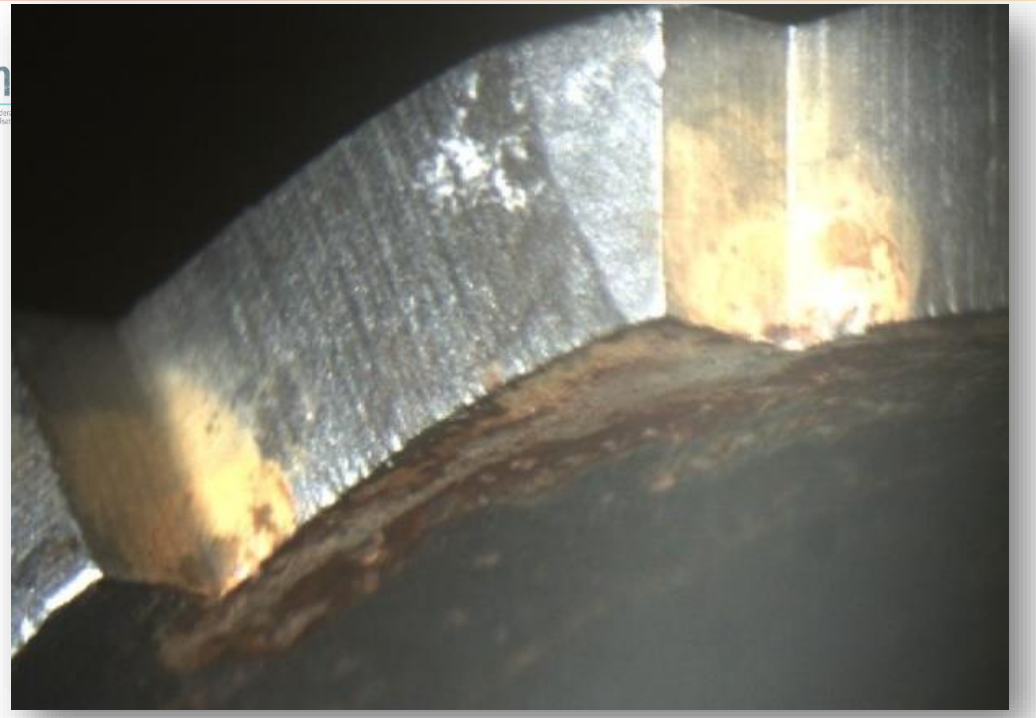
- Cleaning efficacy critical
- Sterilization efficacy critical
- Rust transfer and further damage of intact instruments
- Costs for repair and exchange

→ Costs and consequential damage

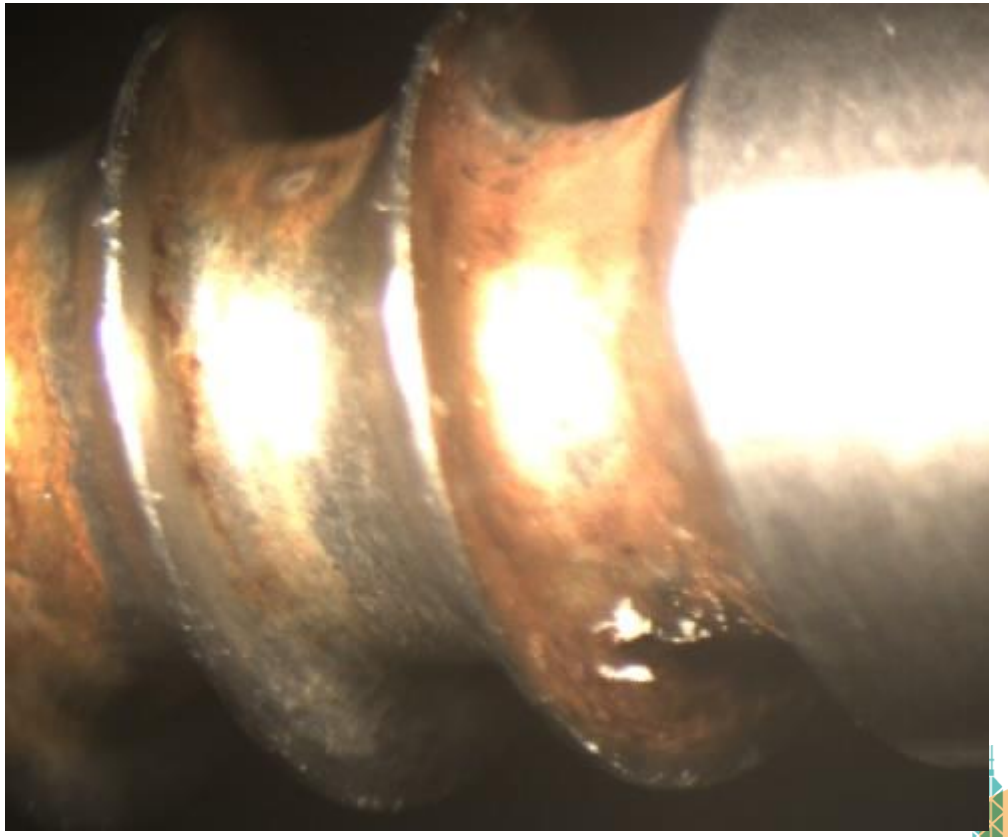





ALWAYS REMEMBER:
1. IF YOU CANNOT CLEAN IT, DO NOT STERILE IT.
2. IF YOU DO NOT KNOW WHAT YOU ARE DOING IS WRONG, YOU ARE FORGIVEN AND IF YOU KNOW YOU ARE WRONG AND YOU STILL CONTINUE DOING IT, YOU COMMIT SIN.



Orthopedics



- Starting - Heavy contamination
- Reason - Delayed reprocessing
- Insufficient precleaning / cleaning

Point of use treatment – Corrosion prevention by instrument foam?

INSTRUCTIONS*

* *Check with medical device manufacturers instructions for use and material compatibility*

- Spray undiluted directly onto the surgical instruments after surgery
- Ensure complete wetting of instruments

Use of Foam Spray?

- **Analysis of Stainless Steel and Anodized Aluminium Material Compatibility with Foam Sprays Used for Keeping Used Surgical Instruments Moist,** *Information from the ”Working Group Instrument Preparation“ (AKI), H. Biering, W. Fuchs, J. Staffeldt, Central Service* 2010; 18 (4) : 235–243

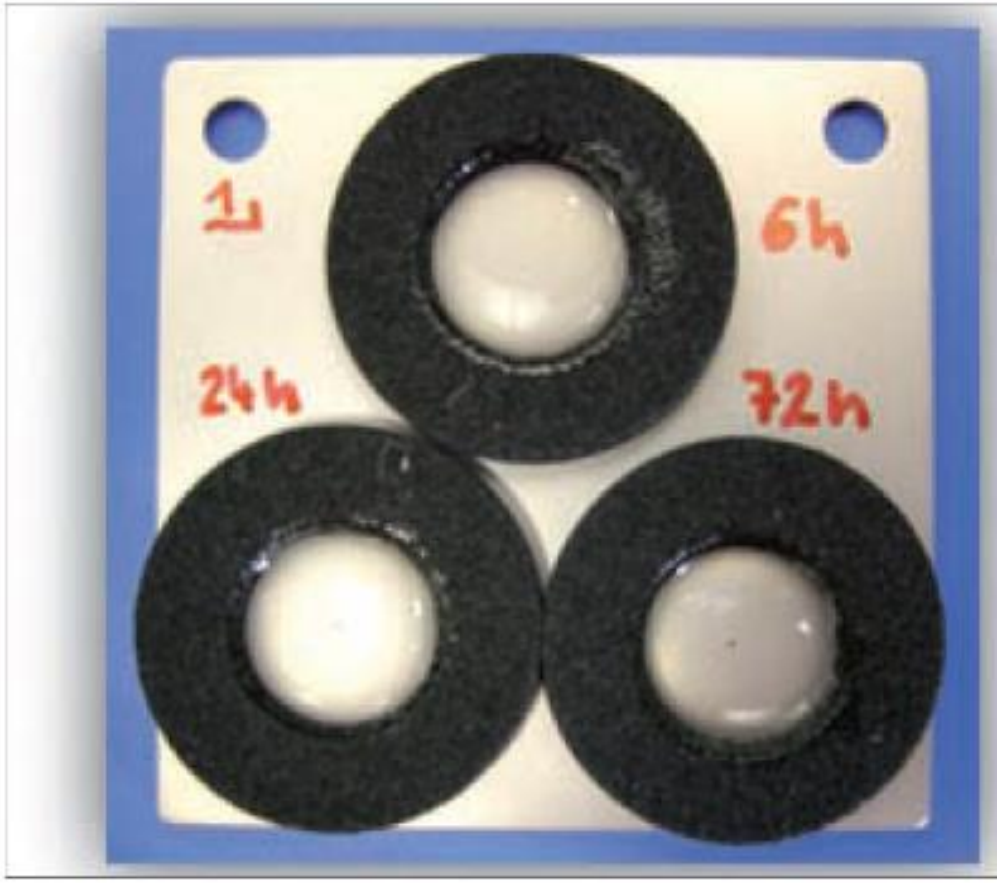
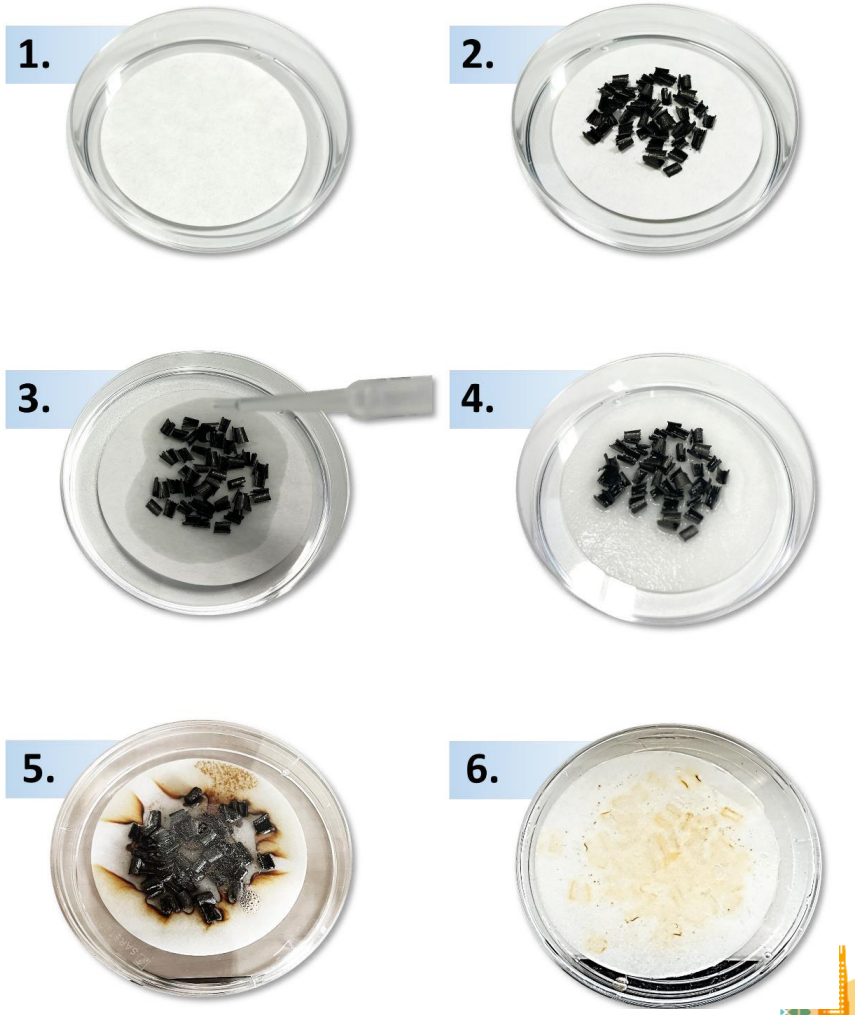


Fig. 1: Ring cell placement on test pieces

Corrosion protection test

DIN 51360

Corrosion protection test for the protection of iron or steel-based materials (products, tools, machines) in contact with water-mixed cooling lubricants, drilling emulsions, cleaners, cooling and quenching media.



Corrosion protection test

Conducted by an accredited third-party institute

HQM INDUSERV

2 Performance

Process	Corrosion chip filter test according to DIN 51360-2** (1981-07) Double determination
Device	2g dry gray cast iron chips GG 25, Exposure time 2h to 2 ml medium at RT

3 Test results

Sample	Result 1. Test	Result 2. Test
1. deionized water (conductivity: 0,4 µS/cm)	 *(Net weight chips: 1,98 g)*	 *(Net weight chips: 2,01 g)*
2. Saline solution 0.9% m/V in deionized water	 *(Net weight chips: 2,02 g)*	 *(Net weight chips: 2,02 g)*

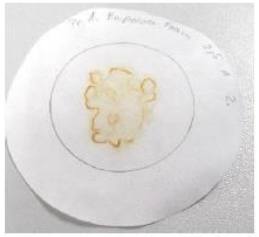
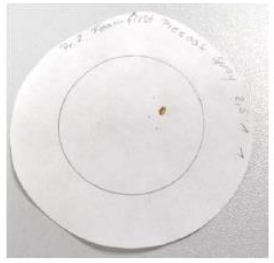
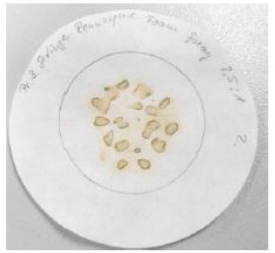
Corrosion protection test

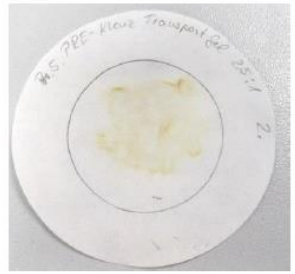
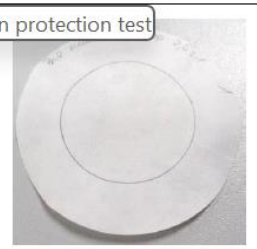
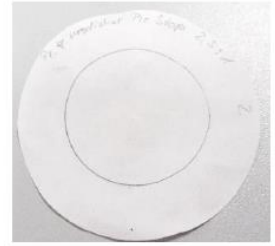
Pure Product Application

Sample	Result 1. Test	Result 2. Test	Sample	Result 1. Test	Result 2. Test
A	 (Net weight chips: 2,00 g)	 (Net weight chips: 1,98 g)	E	 (Net weight chips: 1,97 g)	 (Net weight chips: 2,01 g)
B ✓	 (Net weight chips: 2,02 g)	 (Net weight chips: 2,00 g)	F	 (Net weight chips: 2,03 g)	 (Net weight chips: 1,98 g)
C	 (Net weight chips: 1,99 g)	 (Net weight chips: 1,97 g)	G ✓	 (Net weight chips: 2,01 g)	 (Net weight chips: 2,01 g)
D	 (Net weight chips: 2,00 g)	 (Net weight chips: 2,02 g)	H	 (Net weight chips: 2,00 g)	 (Net weight chips: 1,98 g)

Corrosion protection test

Product + 0.9 % saline solution

Sample	Result 1. Test	Result 2. Test
A	 (Net weight chips: 1,98 g)	 (Net weight chips: 1,99 g)
B ✓	 (Net weight chips: 1,99 g)	 (Net weight chips: 2,02 g)
C	 (Net weight chips: 2,00 g)	 (Net weight chips: 1,98 g)
D	 (Net weight chips: 2,00 g)	 (Net weight chips: 2,02 g)

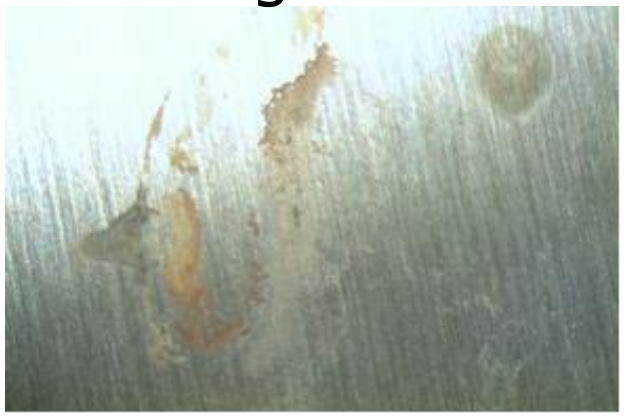
Sample	Result 1. Test	Result 2. Test
E	 (Net weight chips: 1,98 g)	 (Net weight chips: 1,98 g)
F	 (Net weight chips: 1,99 g)	 (Net weight chips: 2,02 g)
G ✓	 (Net weight chips: 2,02 g)	 (Net weight chips: 2,00 g)
H	 (Net weight chips: 1,99 g)	 (Net weight chips: 2,00 g)

Prevention - corrosion inhibition by instrument foam?

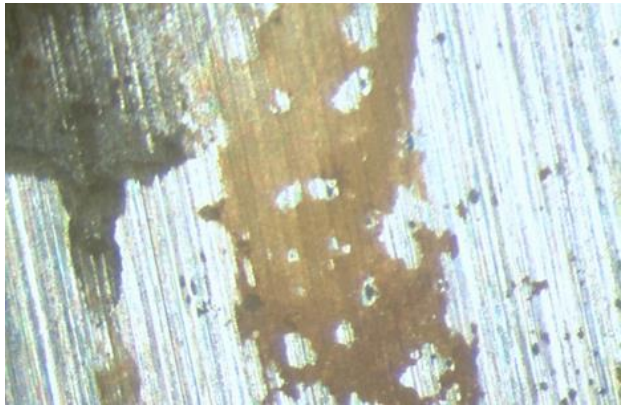
- ✓ Suitable Pre-wetting in operation rooms
- ✓ Corrosion inhibitor prevents pitting corrosion
- ✓ Prevents corrosion up to 72 hours

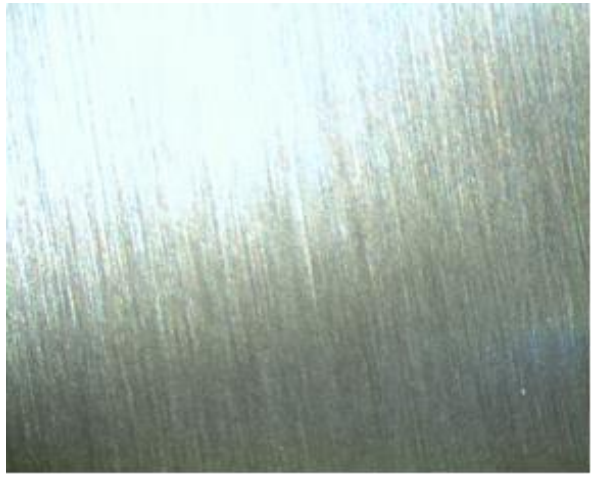
Without corrosion inhibition, 0,2 ml NaCl

7x magnification

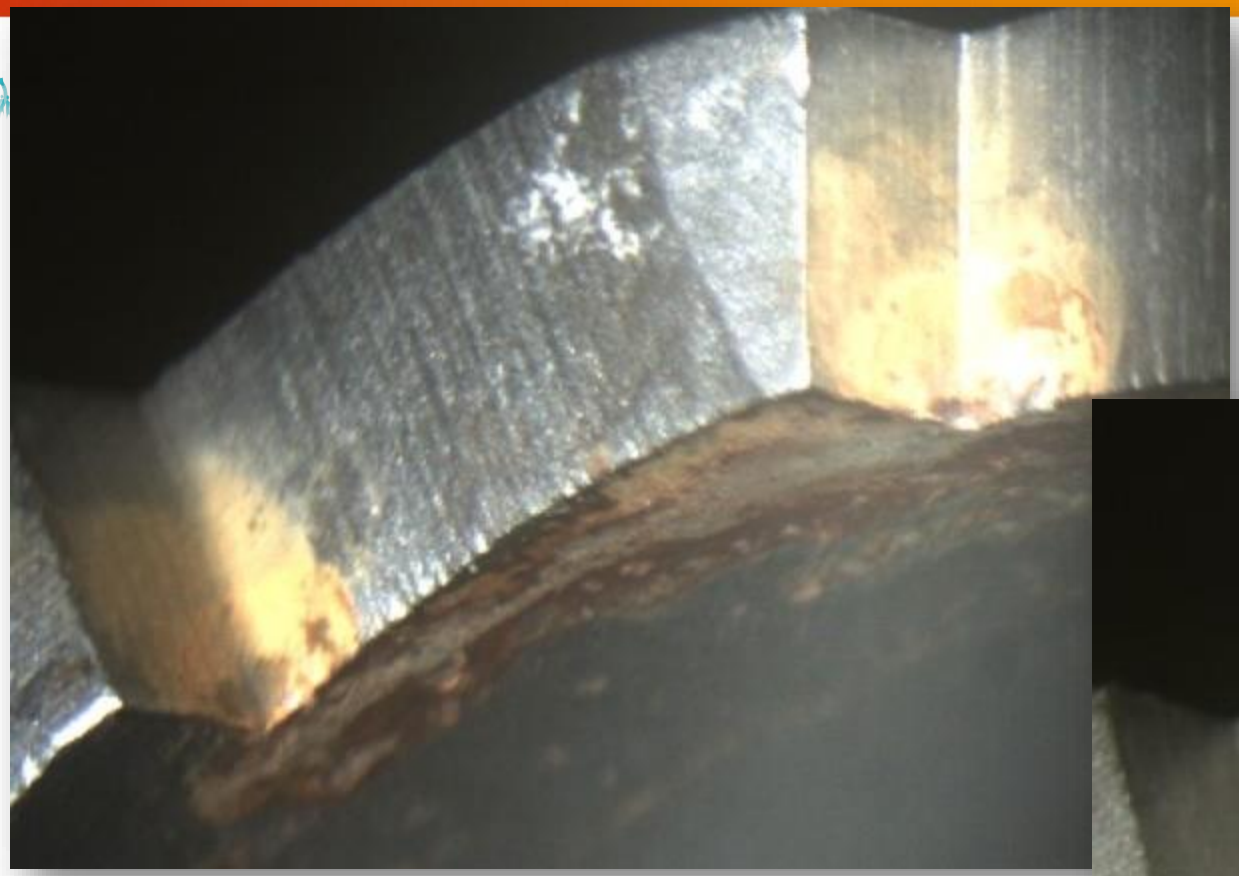


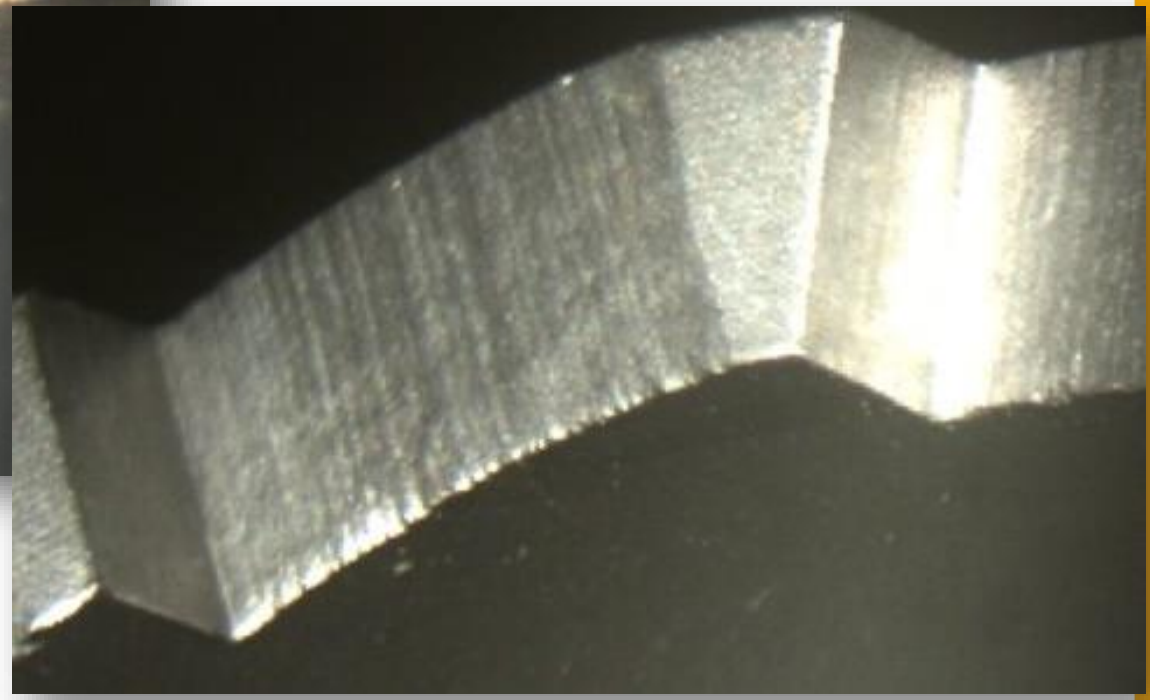
40x magnification





With corrosion inhibition 0,2 ml NaCL + 0,2 ml/l, 7x magnification → pitting corrosion has been avoided 72 h





- **Damage - Corrosion & bone material**
- **Correction - acidic cleaning**
- **Prevention - Revised procedure, fast reprocessing, use of anti-corrosion foam**

Conclusion

- ➢ Corrosion causes hygienic and infection risks
- ➢ Corrosion causes costs for repair and exchange
- ➢ Common corrosions causes are found in the instrument cycle
- ✓ Contact with isotonic solutions should be avoided
- ✓ Chlorides in the water for reprocessing should be as recommended
- ✓ Instrument foams should be tested for corrosion inhibition
- ✓ Joints (metal-on-metal sliding surfaces) should be lubricated in every reprocessing cycle

Thanks to:
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I. Haacke,
Dr. B. Wulff

Thank you!

Dr. Matthias Tschoerner

Chemische Fabrik Dr. Weigert GmbH & Co. KG Hamburg (Germany)