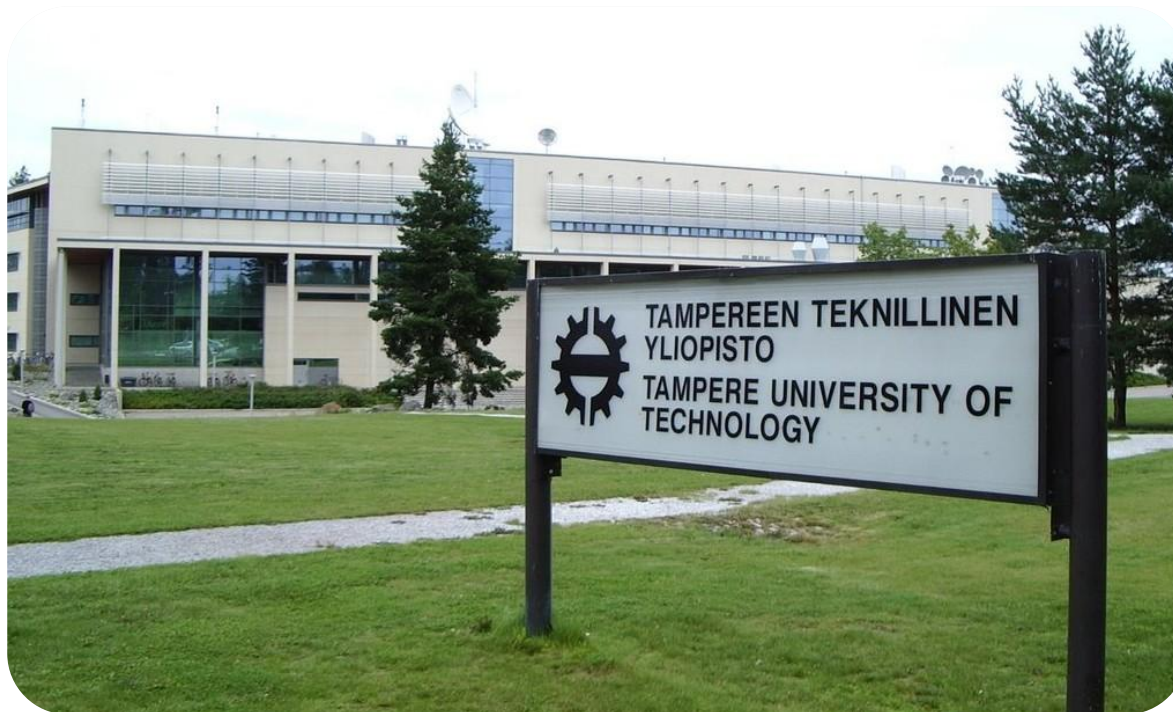


Fellowship TUT



Ing. Jan Schubert
Ing. Zdeněk Česánek

TAMPERE UNIVERSITY OF TECHNOLOGY

- Established 1972
- Staff 1800+
- Students 10 000+
- World wide know by their innovations and quality of study
- Enormous technological background



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TAMPERE UNIVERSITY OF TECHNOLOGY - DEPARTMENTS

- Automation Science and Engineering
- Chemistry and Bioengineering
- Civil Engineering
- Electrical Engineering
- Electronics and Communications Engineering
- Mechanical Engineering and Industrial Systems
- Industrial Management
- Information Management and Logistics
- Intelligent Hydraulics and Automation
- Language Centre
- **Materials Science**
- Mathematics
- Optoelectronics Research Centre
- Pervasive Computing
- Physics
- Pori Department
- School of Architecture
- Signal Processing



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HOT CORROSION STUDY ON THERMALLY SPRAYED COATINGS

- Substrate
 - 1.4923 (Stainless steel)
- Coatings
 - Carbide coatings:
 - Cr_3C_2 -25%NiCr
 - Cr_3C_2 -25%CoNiCrAlY
 - TiMoCN-29%Ni

Alloy based coatings:

- Stellite 6
- Hastelloy C-276
- NiCrBSi



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Experiment

- Samples tested using two temperatures
 - 575°C
 - 525°C
- Corrosion atmosphere
 - 30% moisture
 - NaCl 6,5%
 - KCl 34,5%
 - Na₂SO₄ 59%



Equipment used for research



Equipment used for research



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Equipment used for research

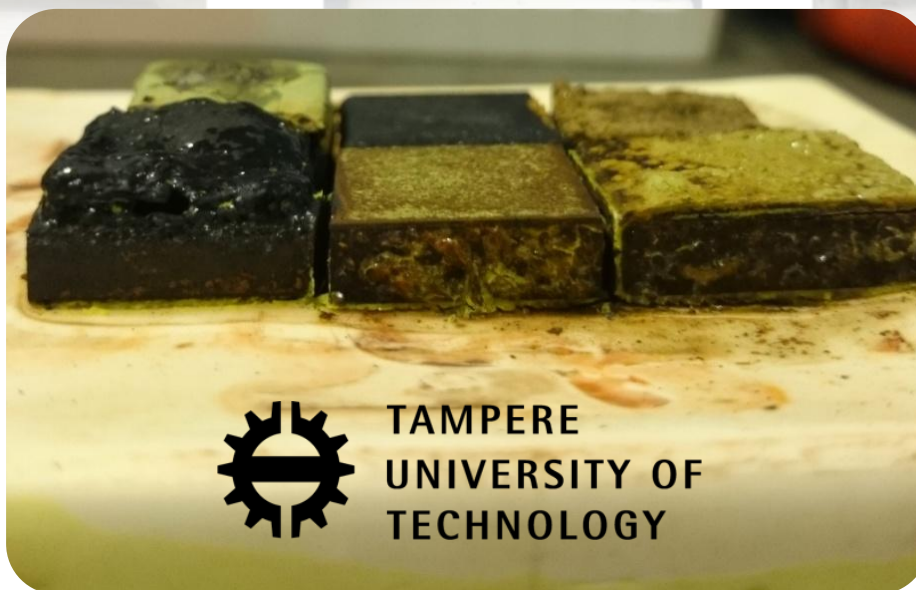
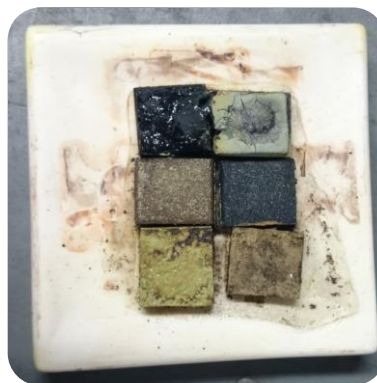


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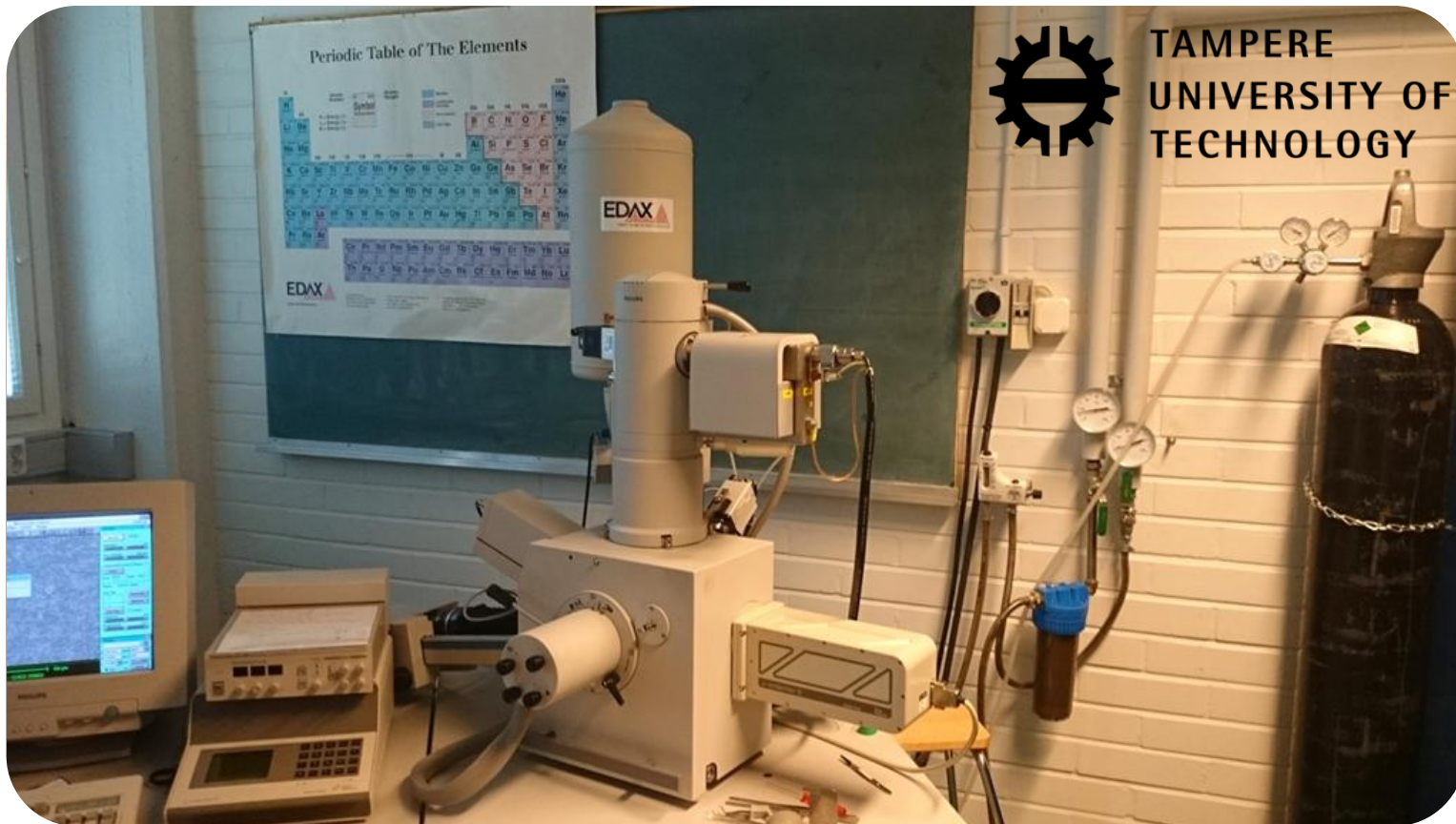
Equipment used for research



Samples preparation

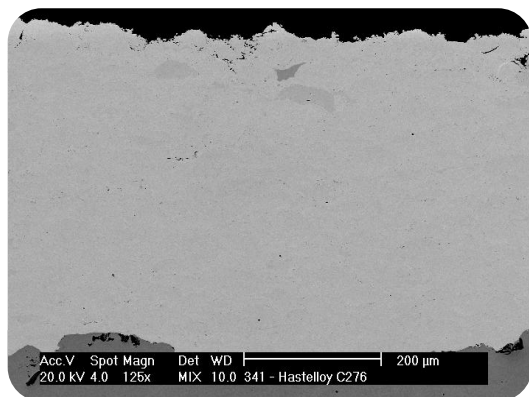


Equipment used for research

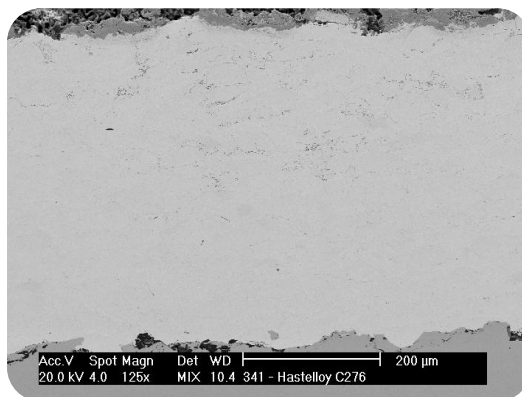


Hastelloy C-276

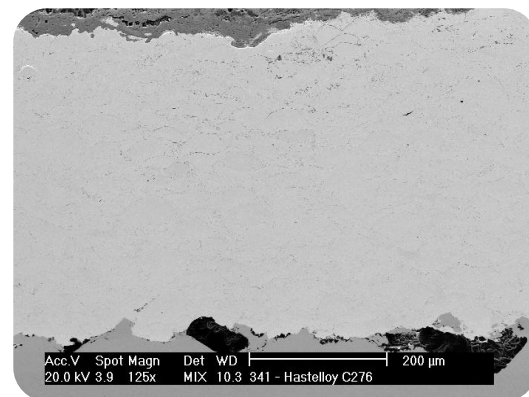
As sprayed



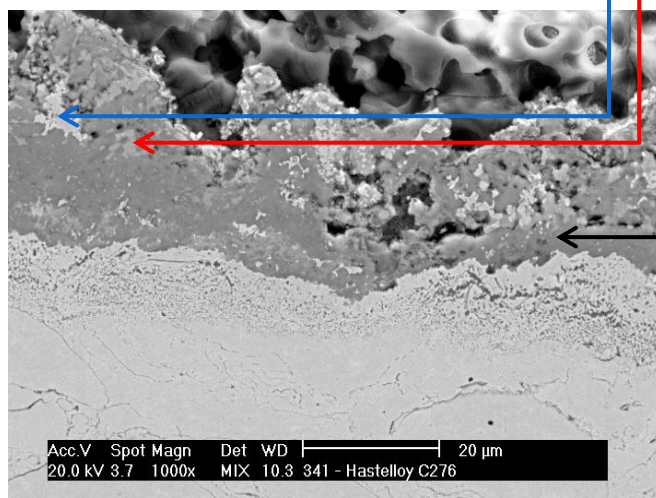
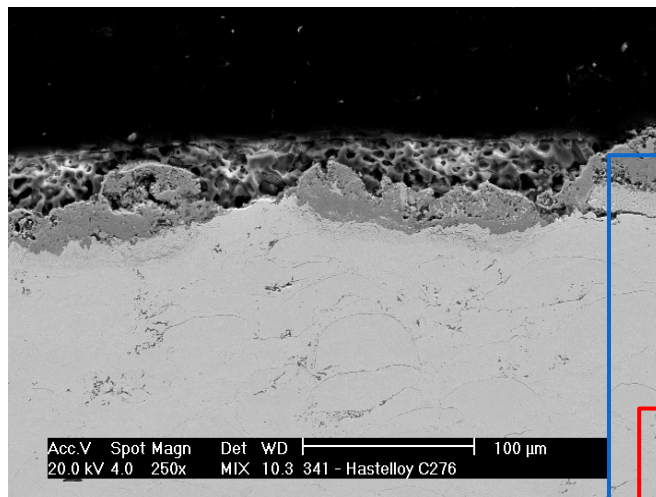
525°C



575°C



Hastelloy C-276 - 525°C

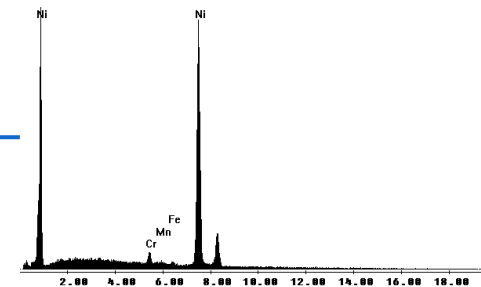


White area - pure Ni

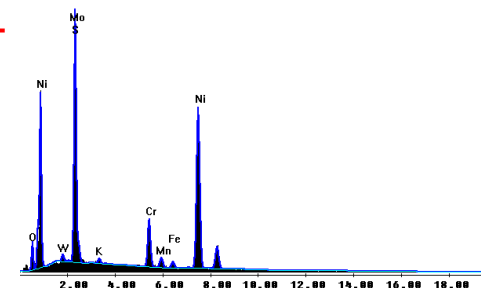
Light grey area

Thick dark oxide

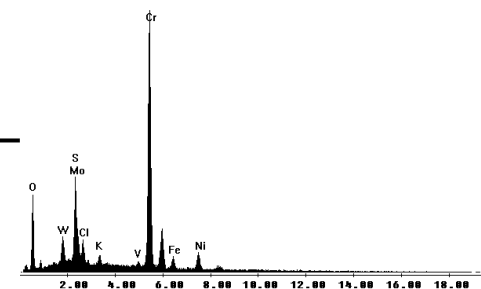
Label A: 341 - 525C - White area in oxide layer



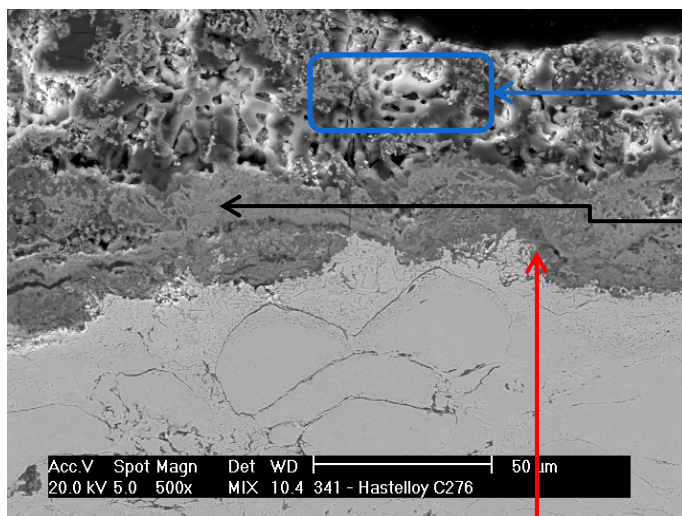
Label A: 341 - 525C - Light grey area in oxide layer



Label A: 341 - 525C - Thick dark grey oxide



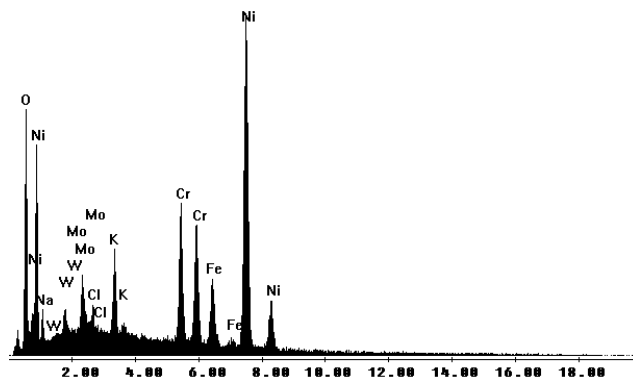
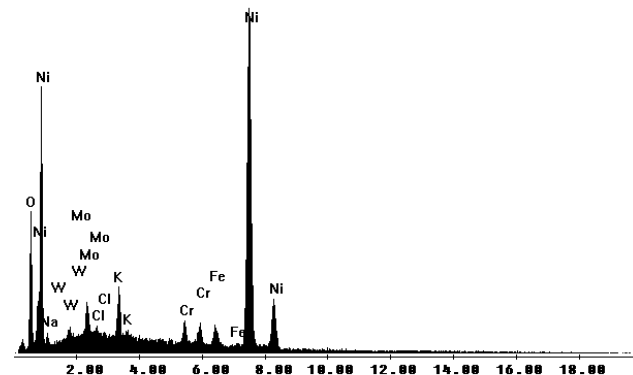
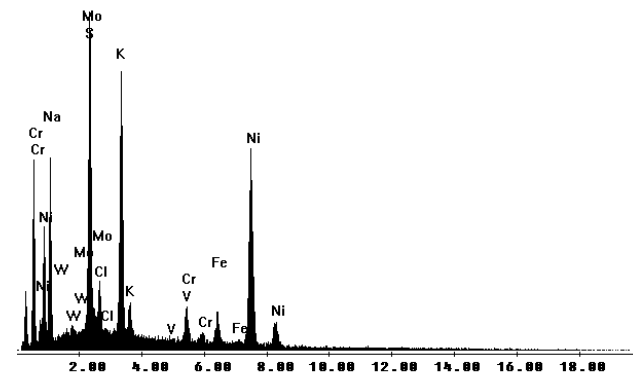
Hastelloy C-276 - 575°C



Mixture of salts
and remains
of coating

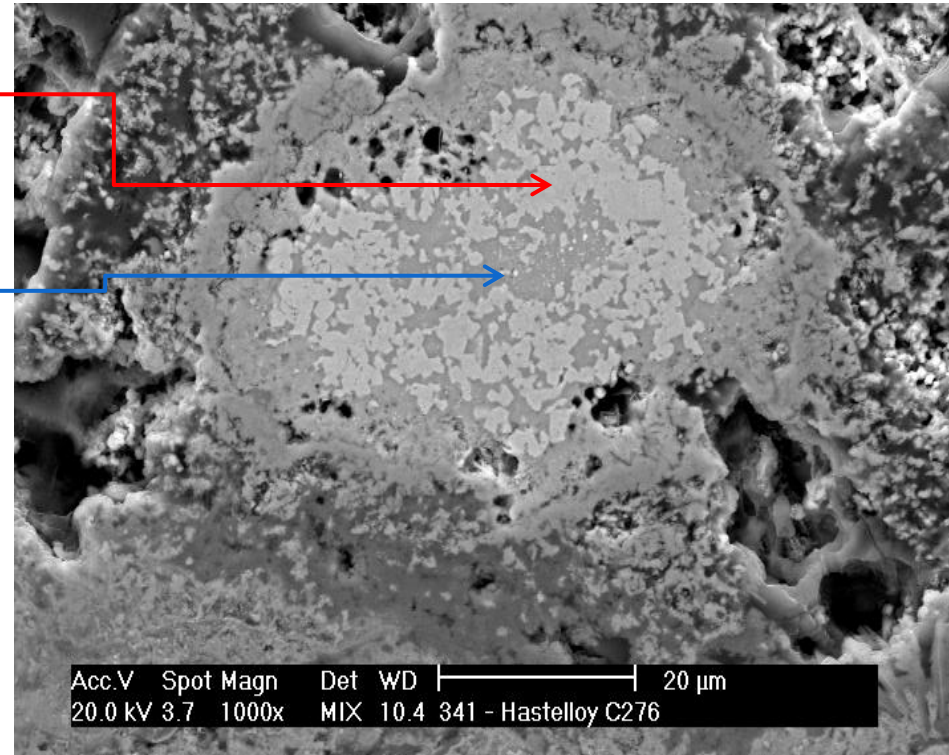
Nickel oxide

Nickel oxide + salts



Hastelloy C-276 - 575°C

- Loosen matrix in salt layer
- Pure Ni
- Ni + Mo

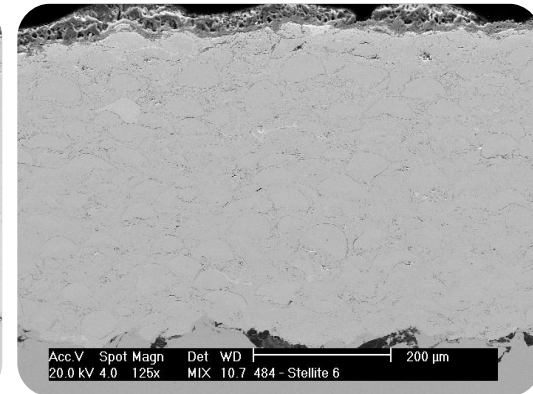
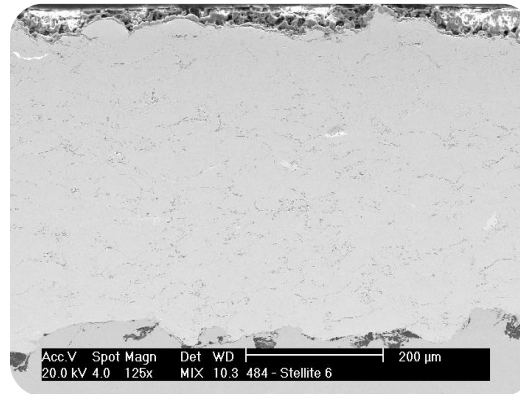
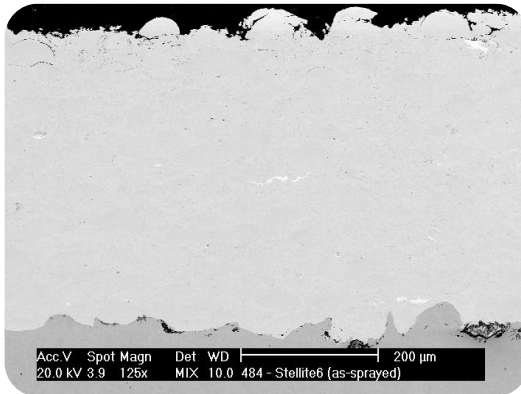


Stellite 6

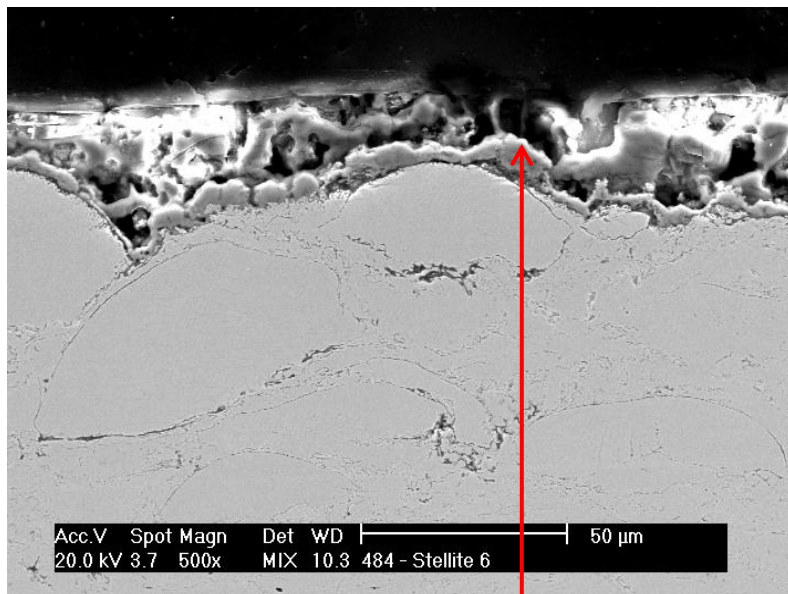
As sprayed

525°C

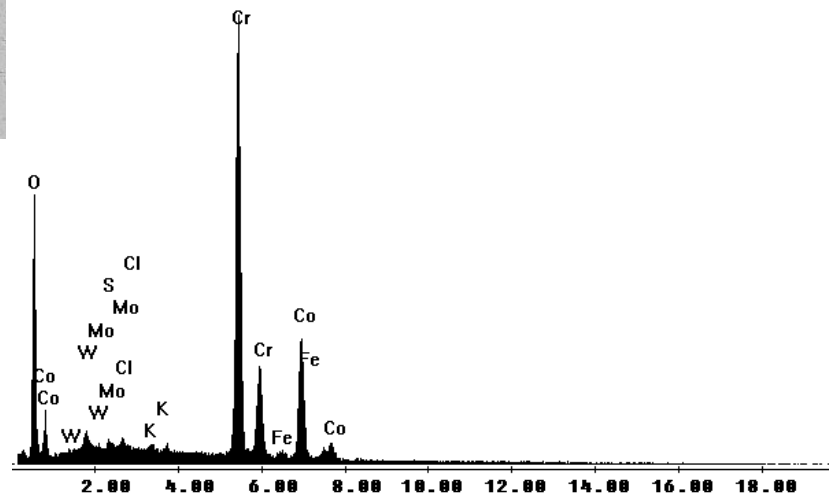
575°C



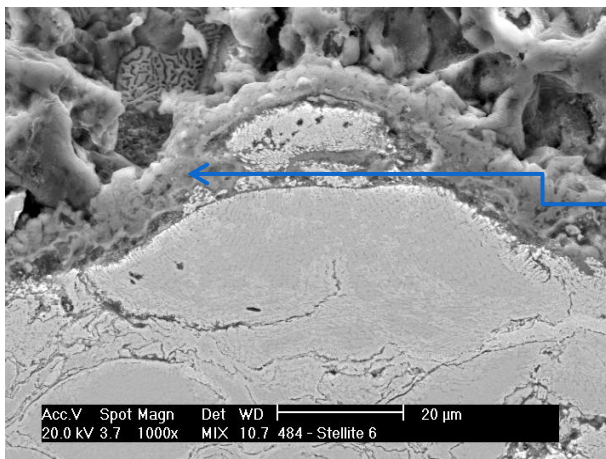
Stellite 6 - 525°C



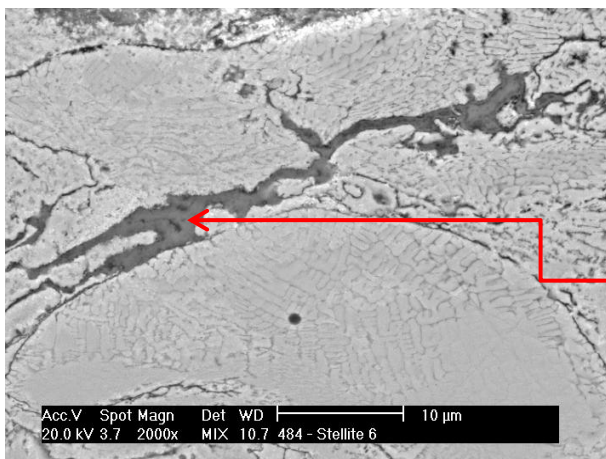
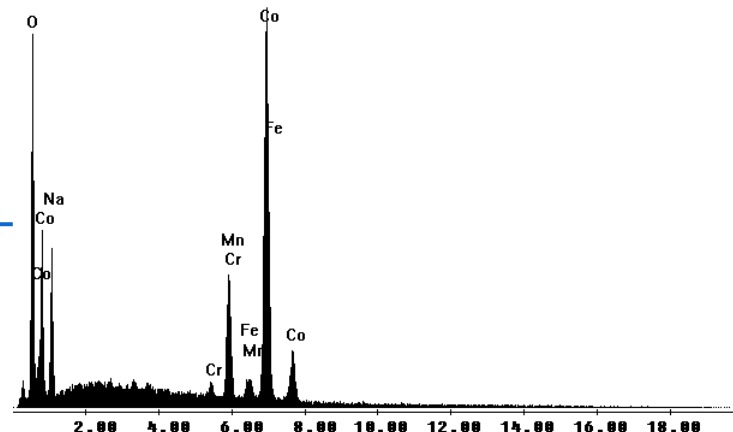
Cr oxide layer



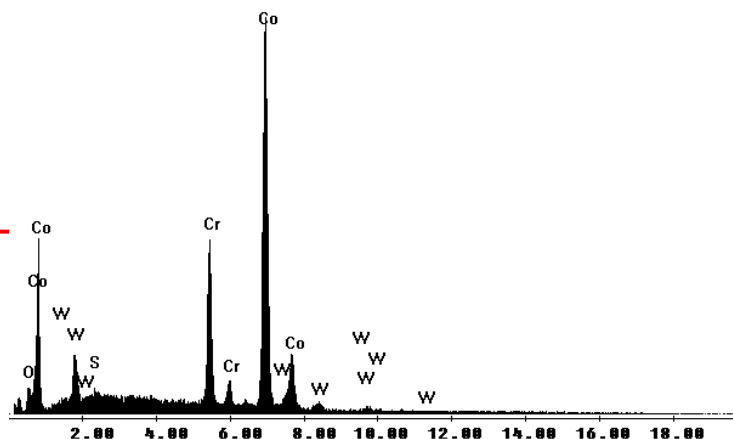
Stellite 6 - 575°C



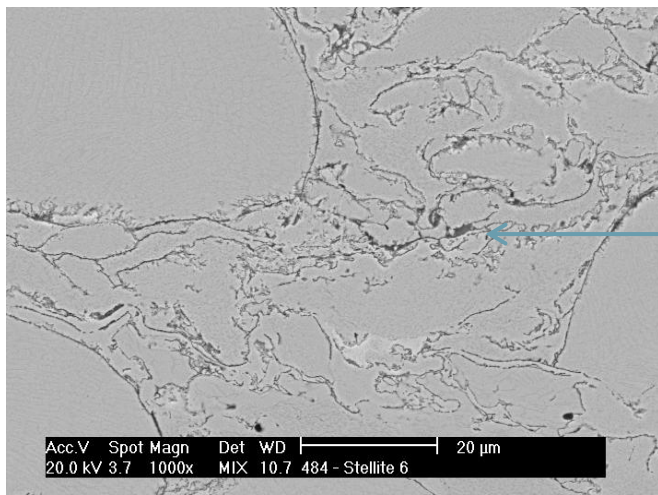
Mixture of oxides
and remaining salts



Mixture of oxides

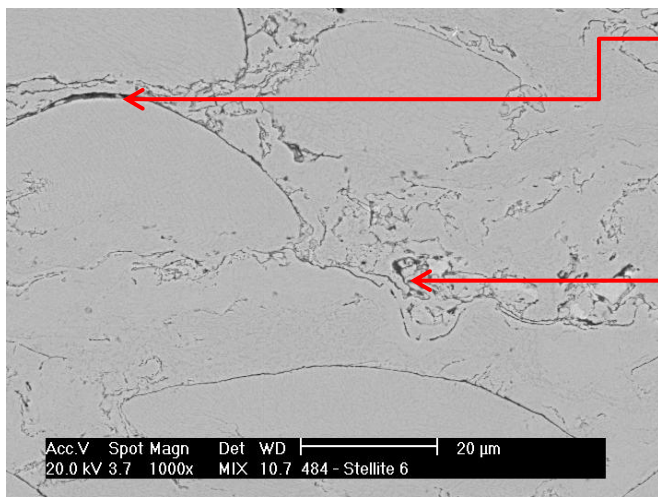
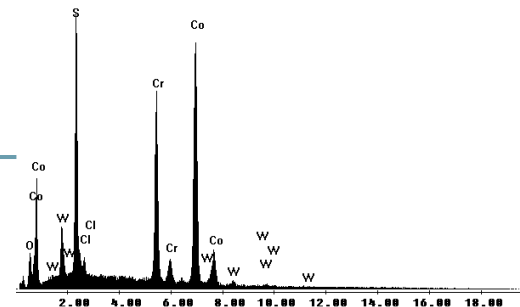


Stellite 6 - 575°C



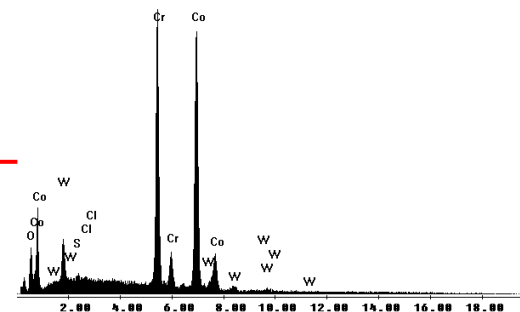
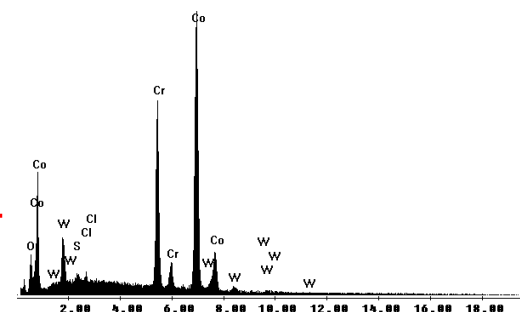
Oxides and remaining
salts at grain borders

- 75µm from surface



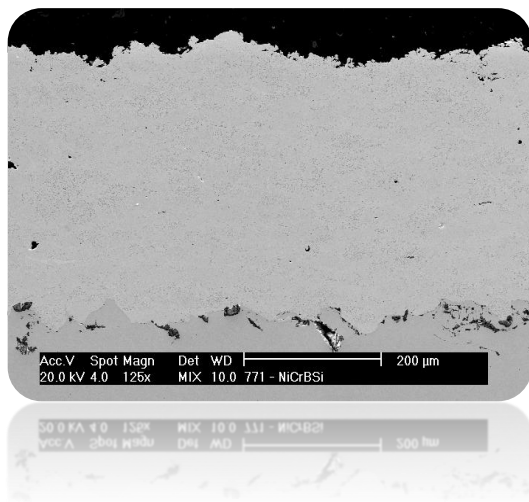
Oxides and remaining
salts at grain borders

- 150µm from surface

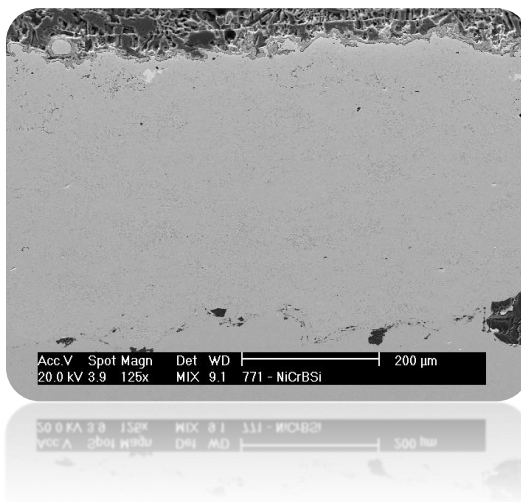


NiCrBSi

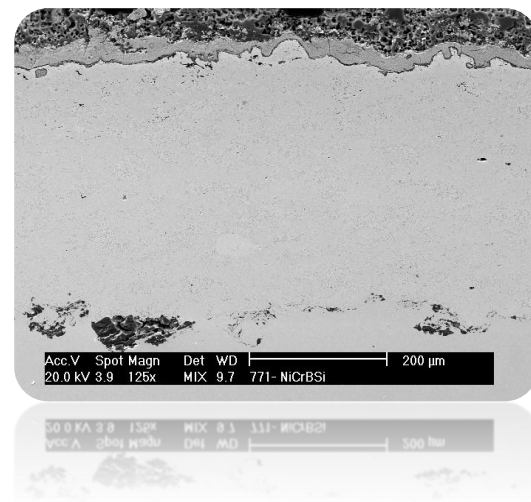
As sprayed



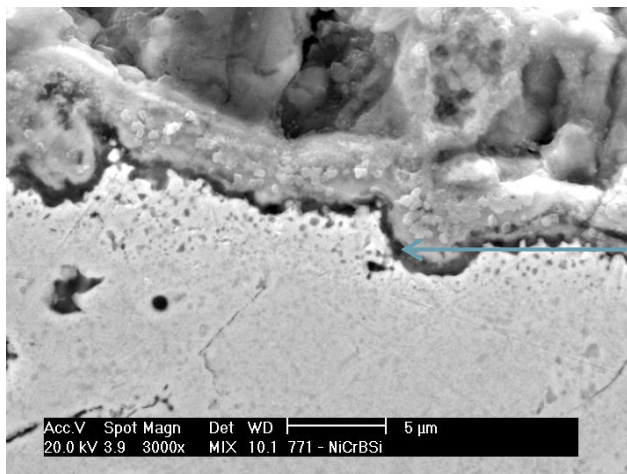
525°C



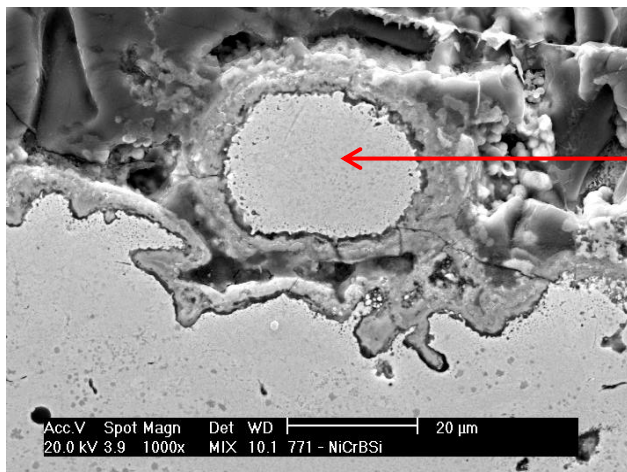
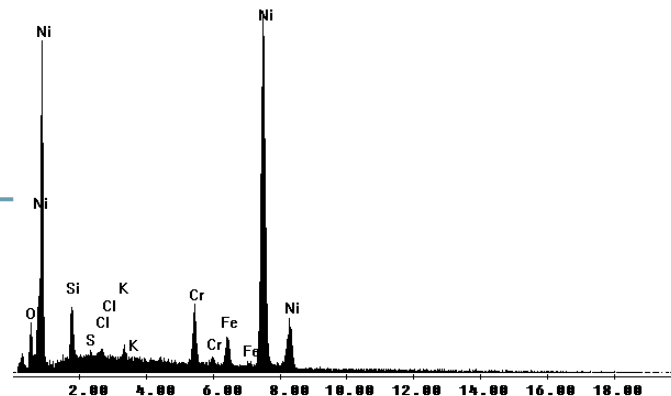
575°C



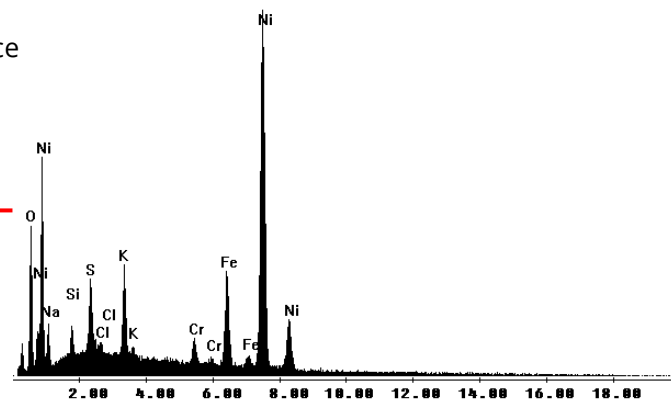
NiCrBSi - 525°C



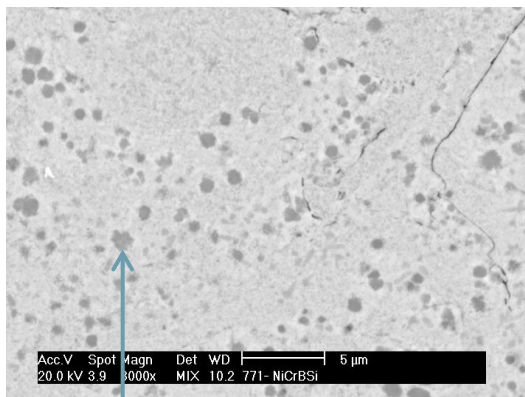
Thin layer on interface
- Ni oxides



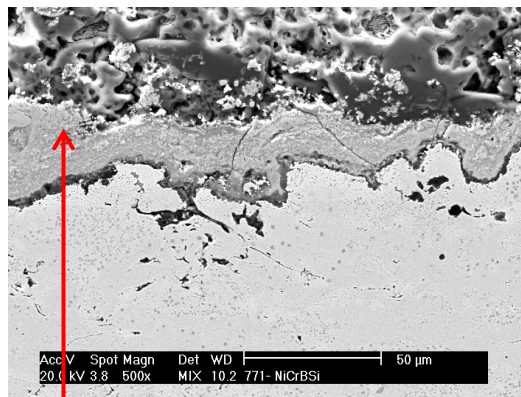
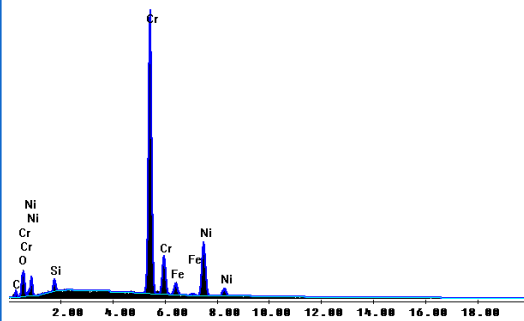
Thick layer on interface
- Ni oxides
- Remaining salts



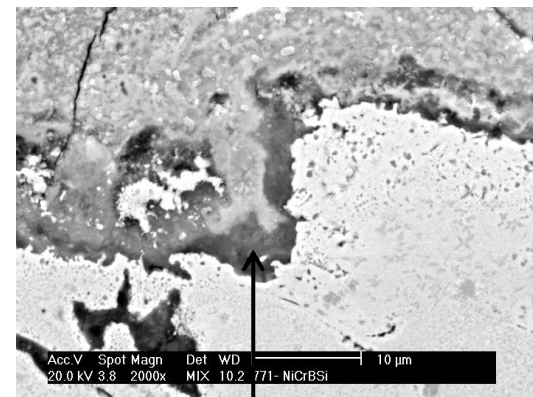
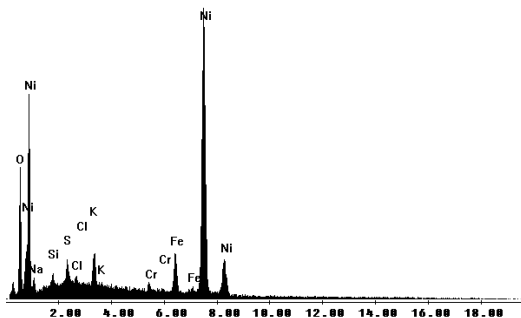
NiCrBSi - 575°C



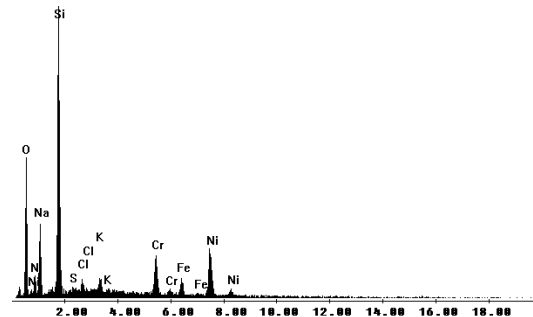
Cr-Ni phase



Thick oxide layer
- Ni oxides
- White dots are crystals of salts

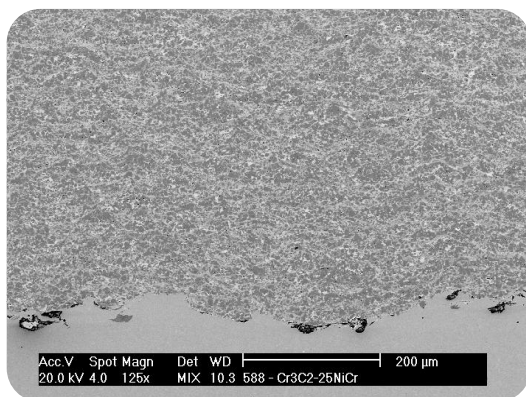


Thin oxide layer
- Probably Si oxides
- Remaining salts

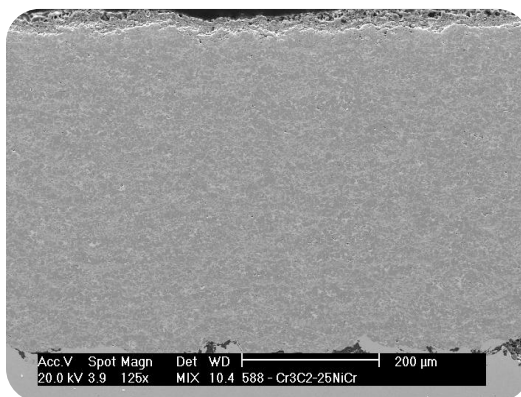


CrC-25%NiCr

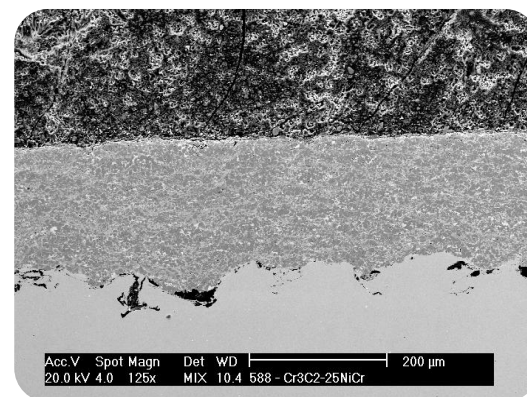
As sprayed



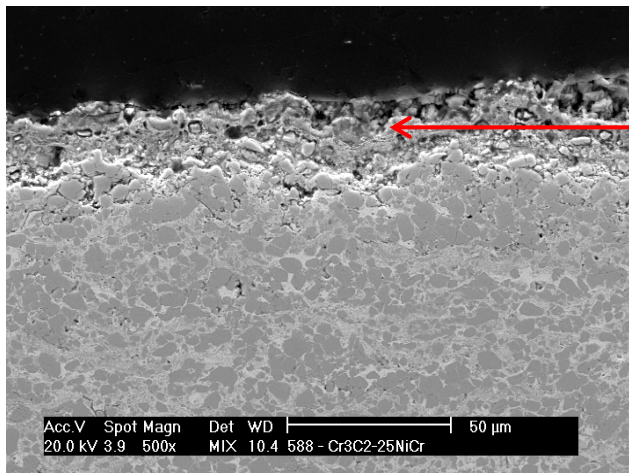
525°C



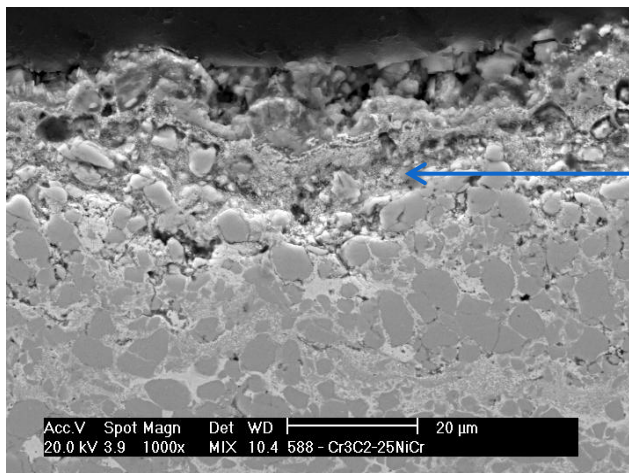
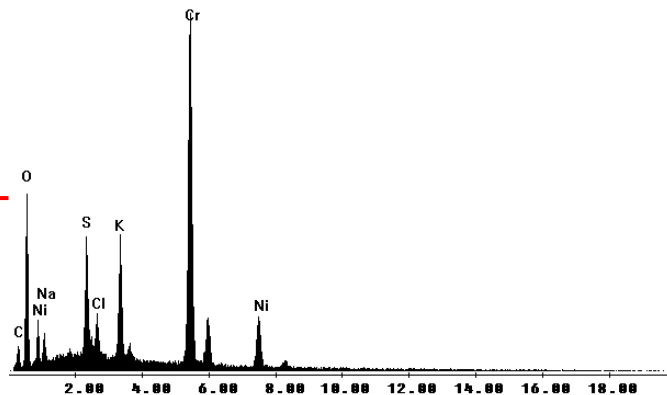
575°C



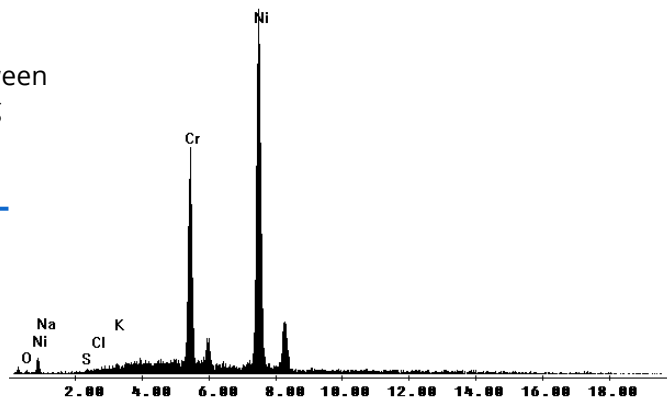
CrC-25%NiCr - 525°C



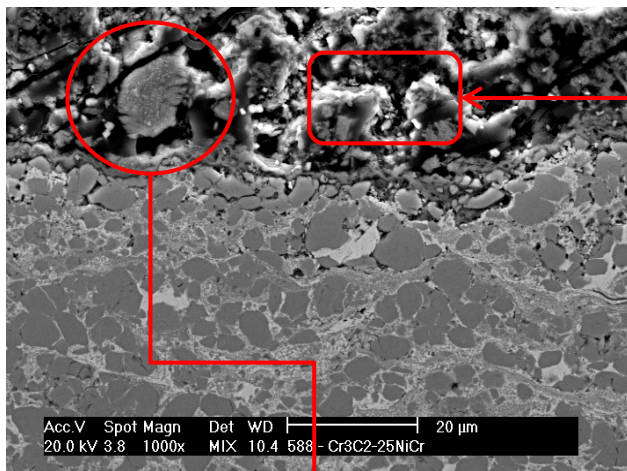
Cr oxide layer with
remaining salts



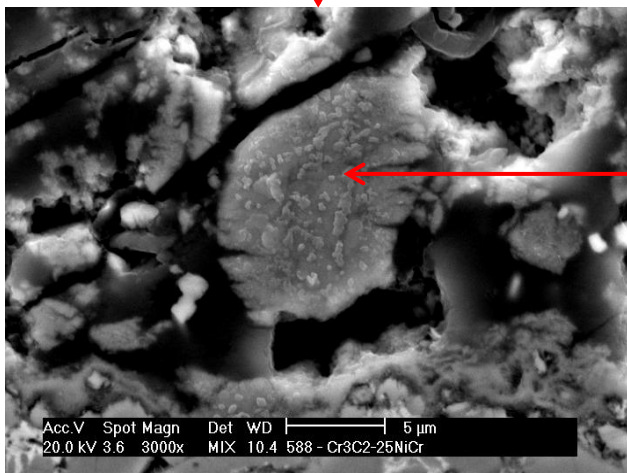
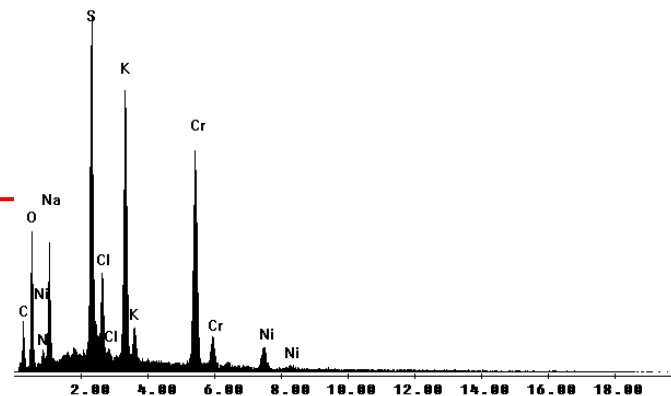
Remaining matrix between
oxide layer and coating



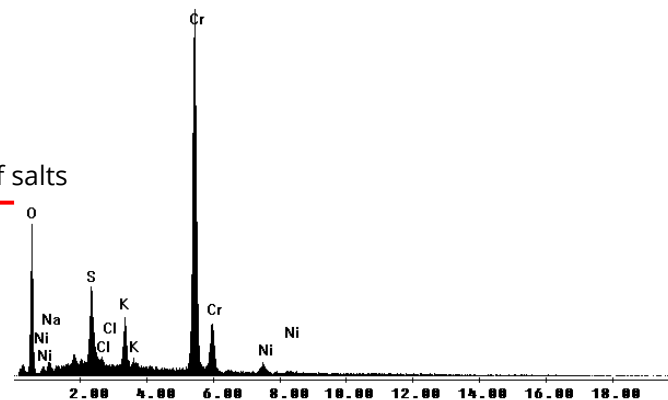
CrC-25%NiCr - 575°C



Salt buildup

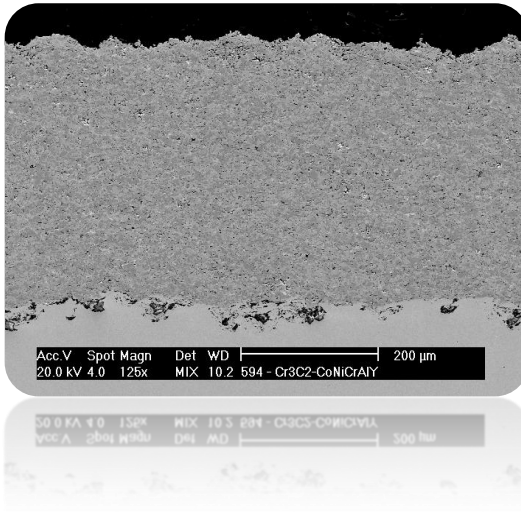


Particle in salt
- Cr oxide
- remaining crystals of salts

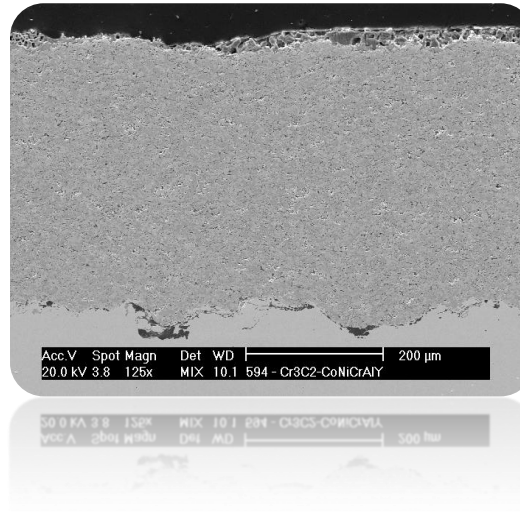


CrC-25%CoNiCrAlY

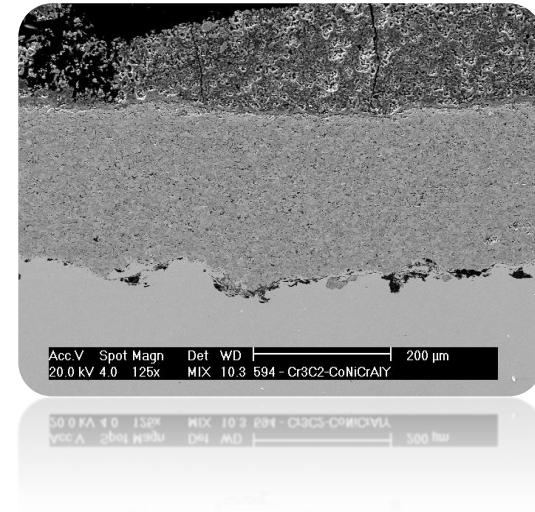
As sprayed



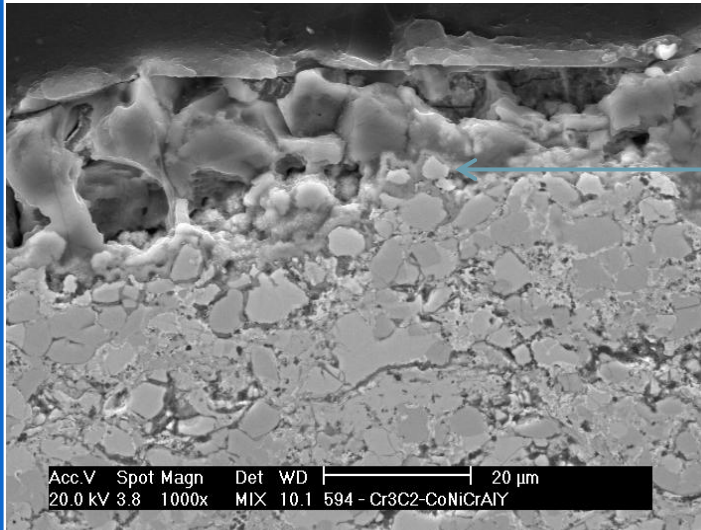
525°C



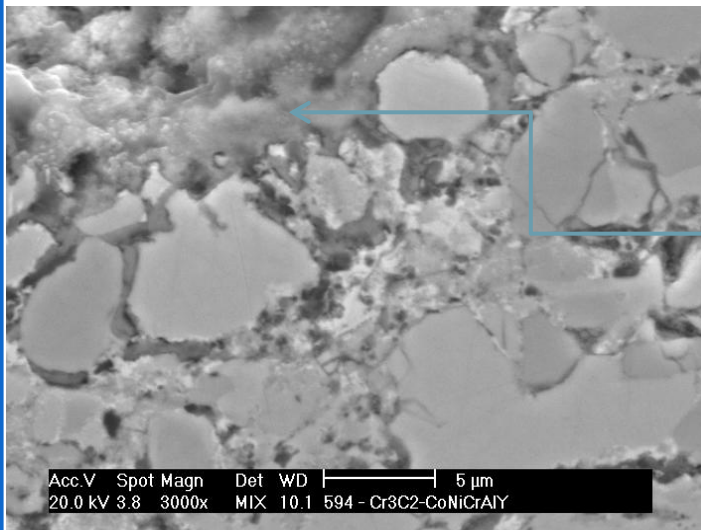
575°C



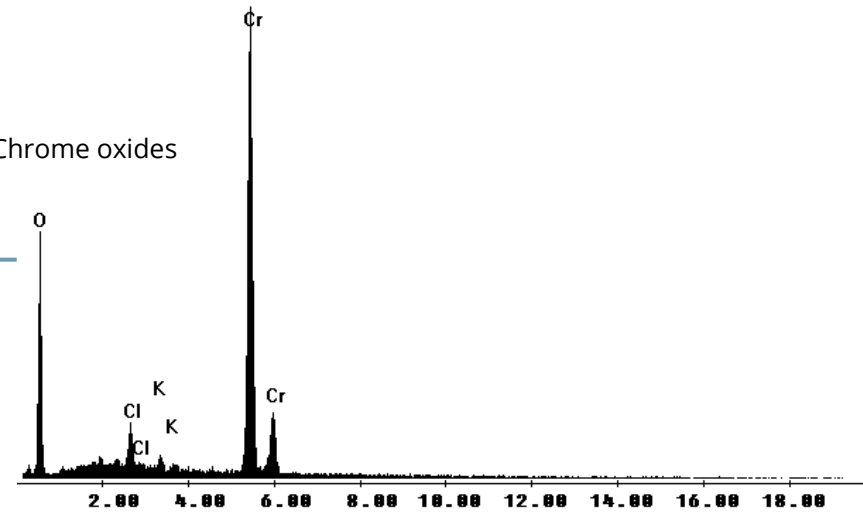
CrC-25%CoNiCrAlY - 525°C



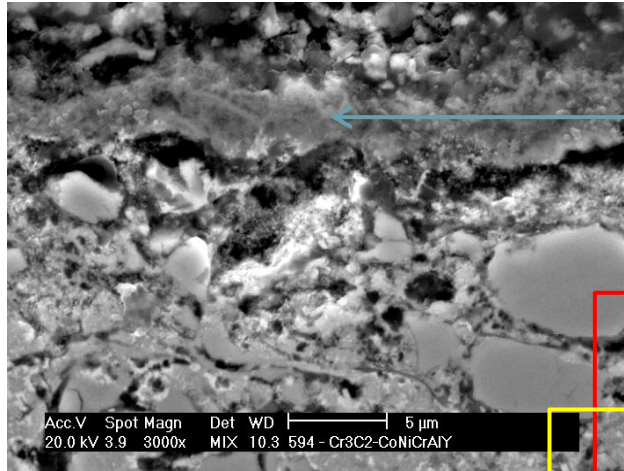
Loosen chrome carbides



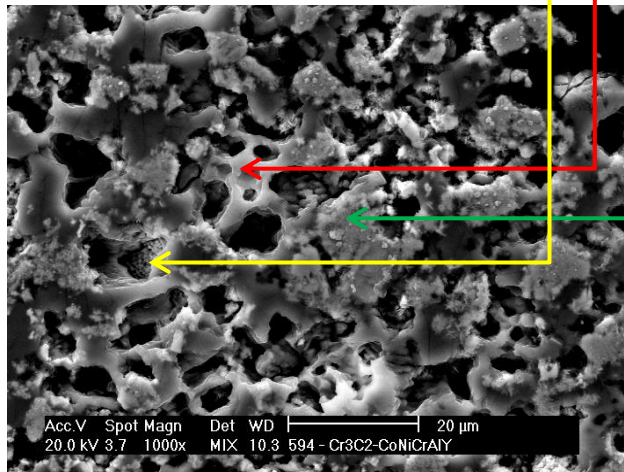
Chrome oxides



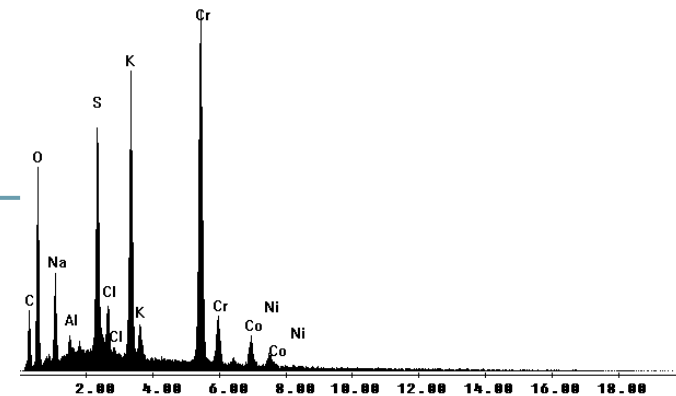
CrC-25%CoNiCrAlY - 575°C



Oxide layer on top of the coating
- Consists from Cr oxides

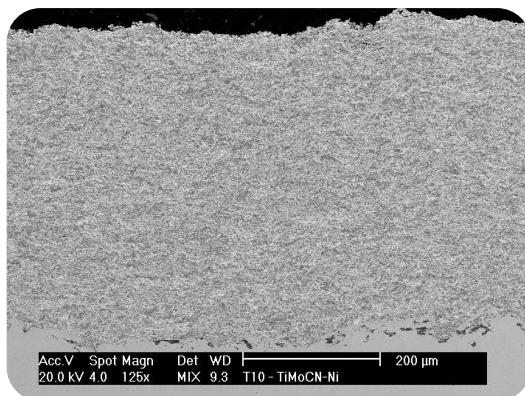


Buildup on oxide layer
- Consists from salts
- Chrome oxides
- Chlorides

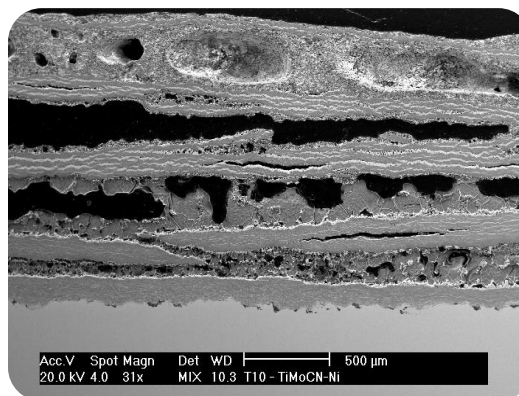


TiMoCN-Ni

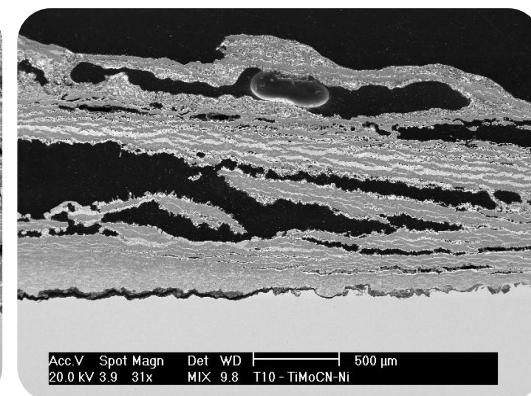
As sprayed



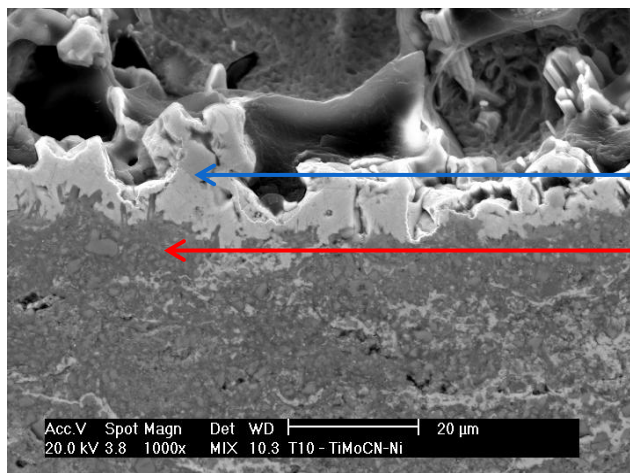
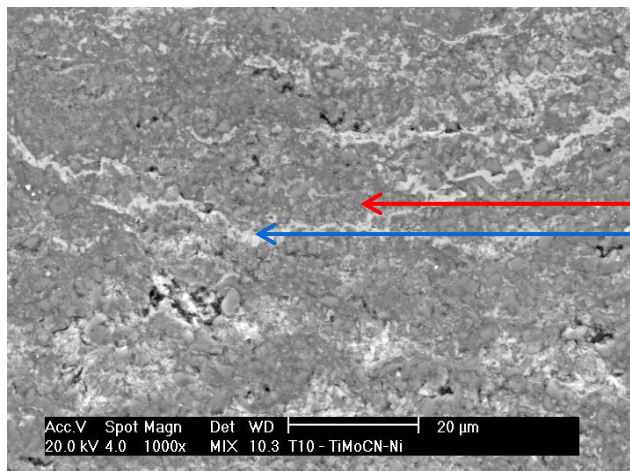
525°C



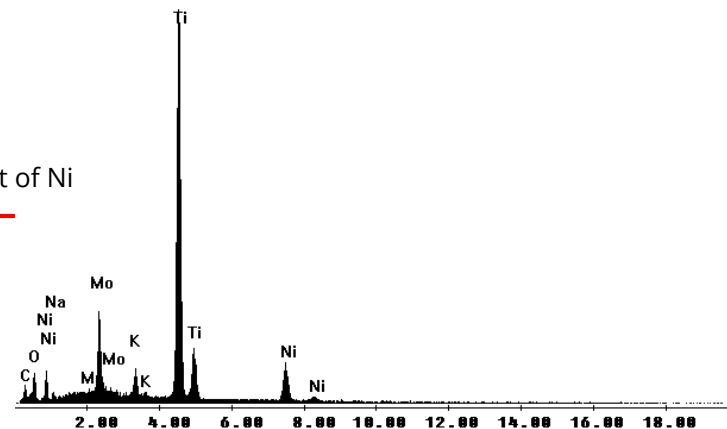
575°C



TiMoCN-Ni - 525°C

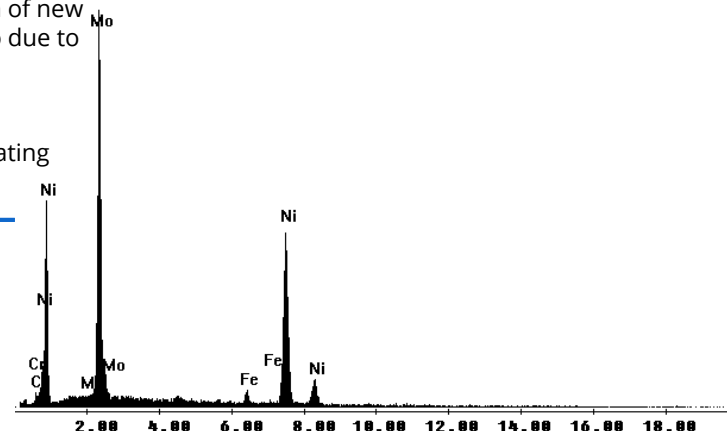


Lower content of Ni

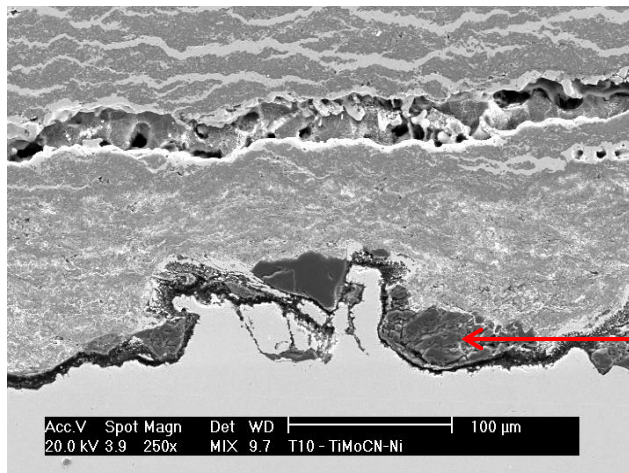


Probable formation of new
phase of Ni and Mo due to
high temperature
exposure

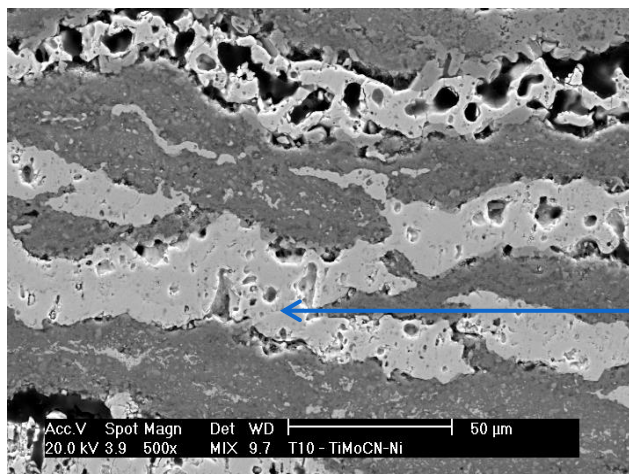
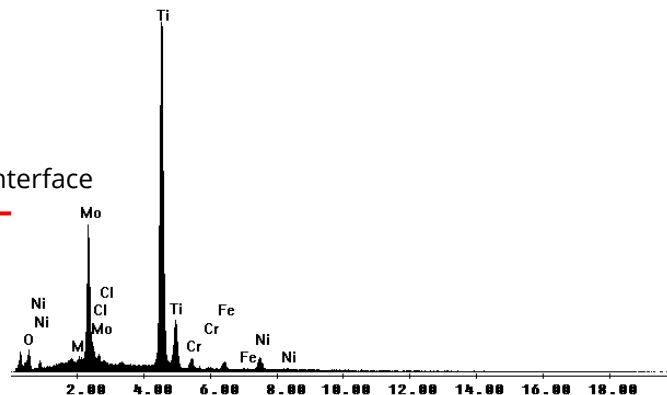
- Destructive for coating



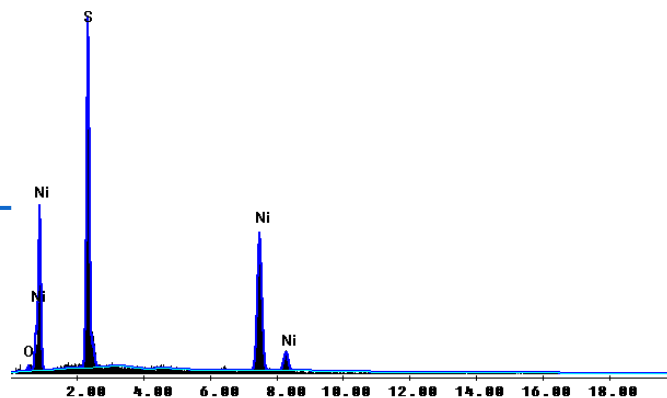
TiMoCN-Ni - 575°C



Particle boundary near interface



Probable new phase of
Ni and Mo causing
destruction of coating





Thanks to project ESF OPVK "Integrita,, and VZU Pilsen

