

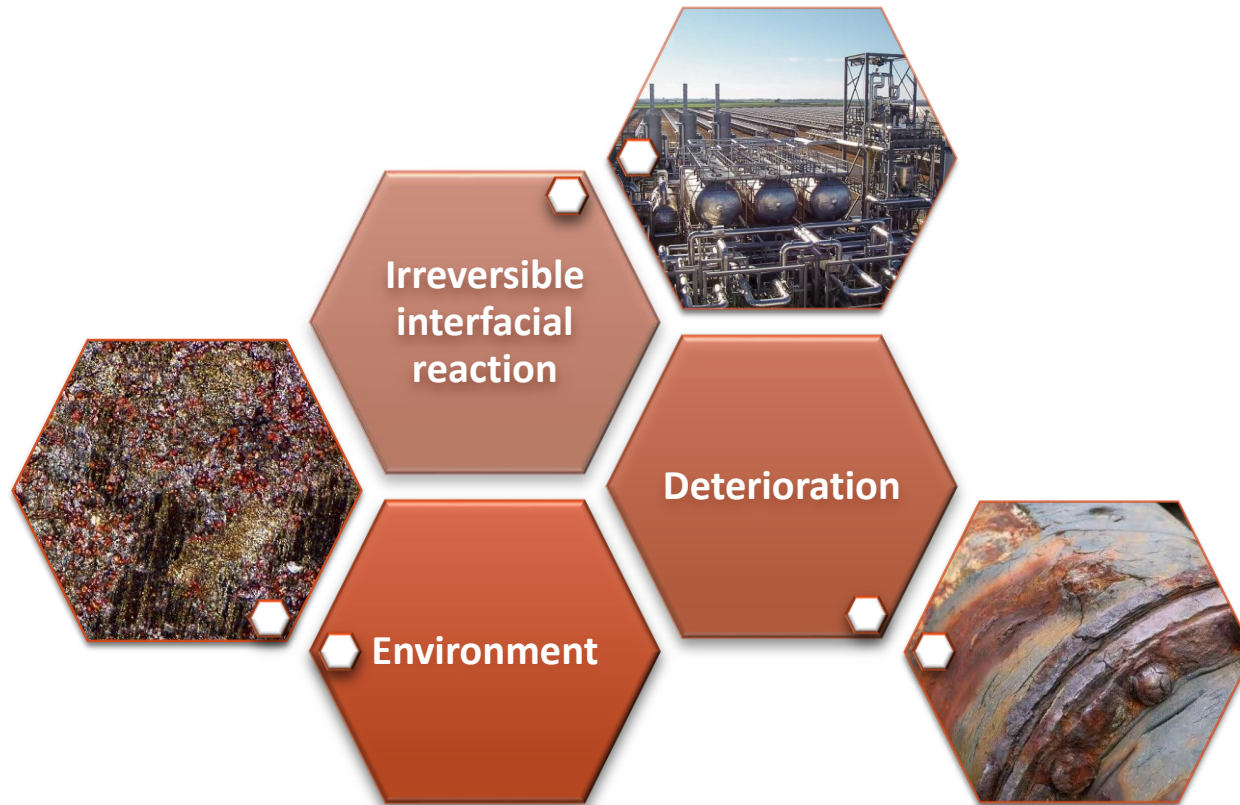
2nd EU-SOLARIS DOCTORAL COLLOQUIUM and 1st EU-SOLARIS SUMMER SCHOOL

Molten carbonate salts doped with nanoparticles
for corrosion mitigation in CSP/CST technologies

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Corrosion



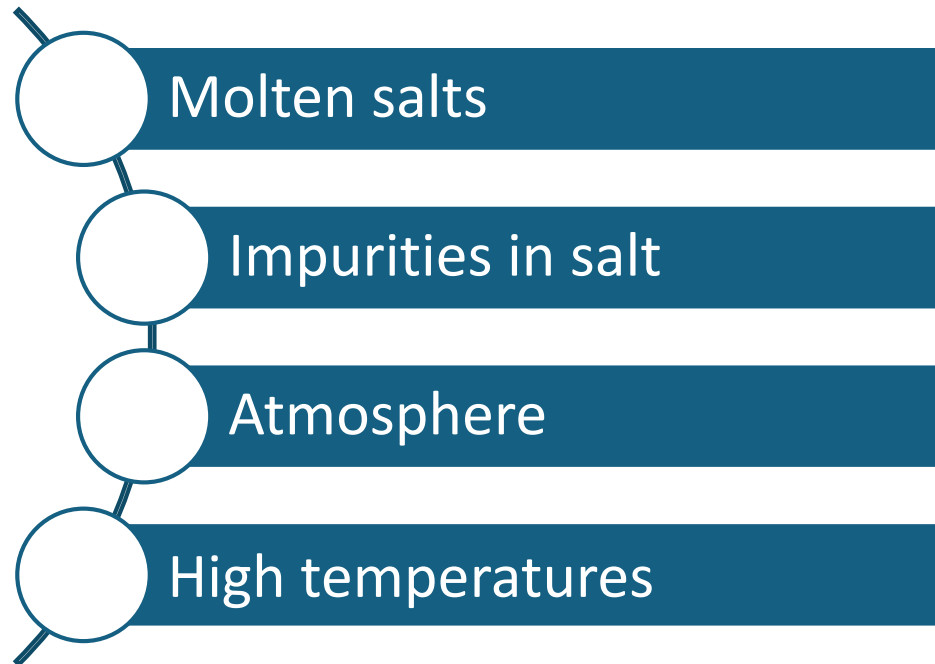
One of the biggest
problems in CSP
plants



Storage tanks
and pipes

Corrosion

Main factors of corrosion of storage tanks and pipes in a CSP plant:



Corrosion mitigation

Nanosalts = molten salt + nanoparticles

Nanoparticles can improve some thermophysical properties:

- ✓ Thermal conductivity
- ✓ Heat capacity
- ✓ Melting point
- ✓ Specific heat
- ✓ Thermal stability
- ✓ Energy storage capacity



Molten carbonate salts doped with nanoparticles for corrosion mitigation in CSP/CST technologies

Objective

- Study of the corrosion of AISI 430 stainless steel in contact with molten LiNaK carbonate salts doped with:
 - ✓ MgO nanoparticles
 - ✓ SiO₂ nanoparticles



Methodology

Grade of steel	Chemical composition (wt.%)											
	C	Mn	Si	P	S	Cr	Ni	Mo	N	Cu	Co	Fe
AISI 430	0.037	0.310	0.350	0.028	0.001	16.260	0.270	0.020	0.048	0.160	0.020	Bal.

Three mixtures of molten salts eutectic Li_2CO_3 - Na_2CO_3 - K_2CO_3 (32.1 : 33.4 : 34.5 wt%)

1. Without nanoparticles
2. 1% MgO nanoparticles (99% purity, 20 nm)
3. 1% SiO_2 nanoparticles (99.5% purity, 10~20 nm, non-porous)

Methodology

1. Mixture preparation

- Mechanical mill for 5 min
- Clean room

2. Steel preparation

- Polishing with P320 sandpaper
- Degreasing with ethanol

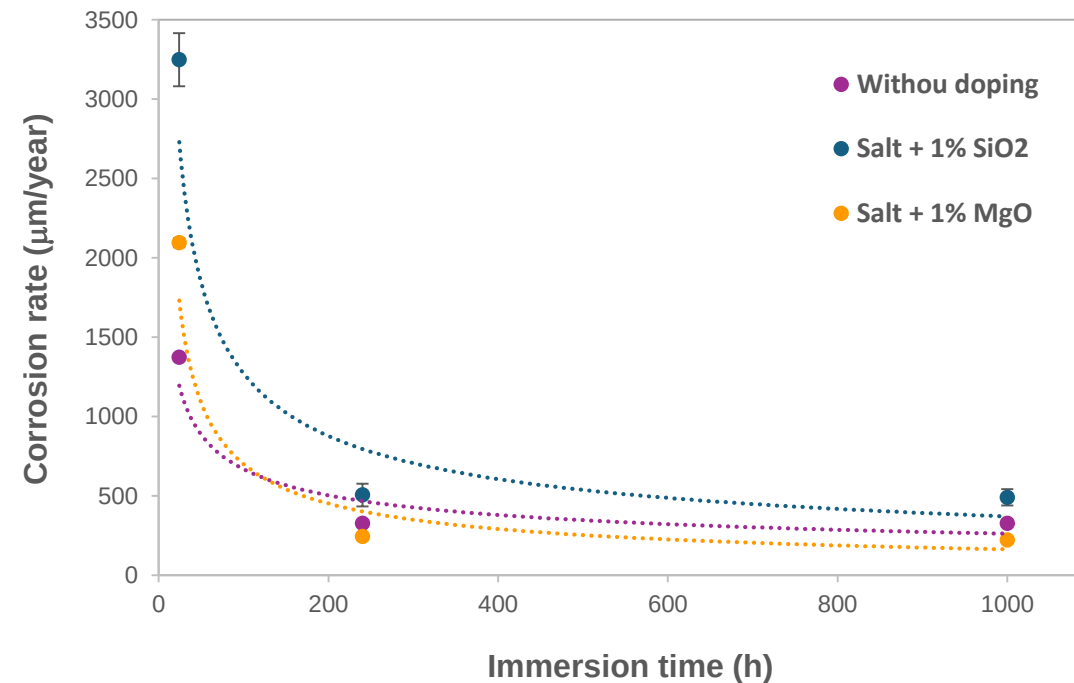
3. Corrosion tests at 650 °C during 24h, 240h, 1000h in atmospheric air



Corrosion rate

Descaling process:
Method C.7.10 - ISO
17245:2015

$$CR(\mu\text{m}/\text{yr}) = \frac{87600\Delta m}{\rho t}$$



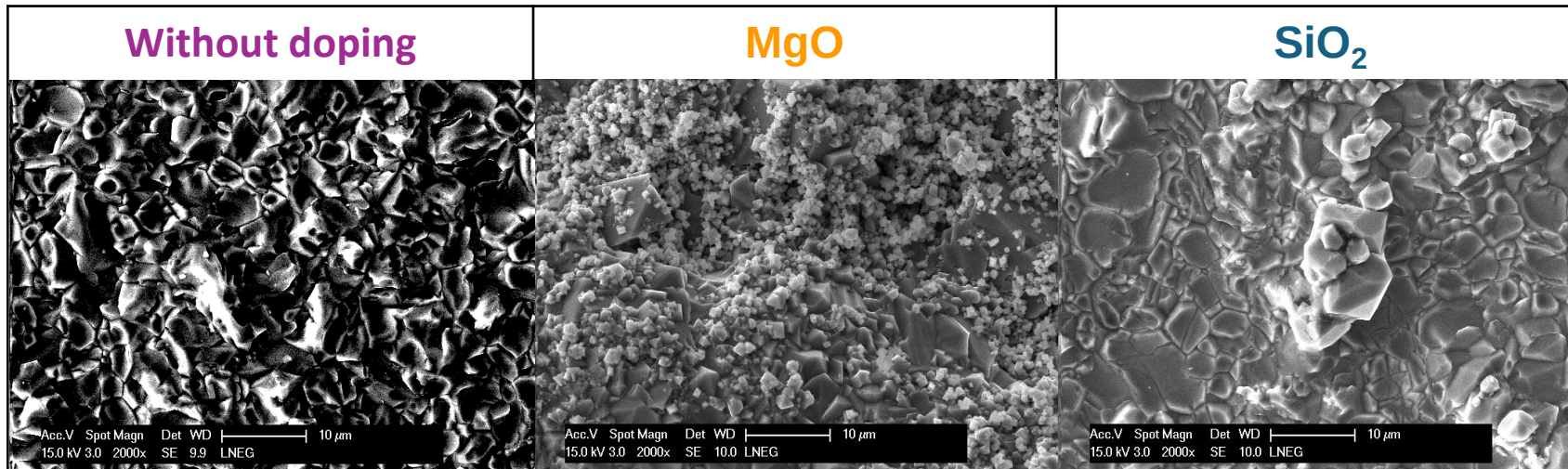
CR (1000 h)

SiO₂: 490 ± 52 μm/year

Without: 326 ± 51 μm/year

MgO: 221 ± 4 μm/year

SEM/EDS - Morphological top view

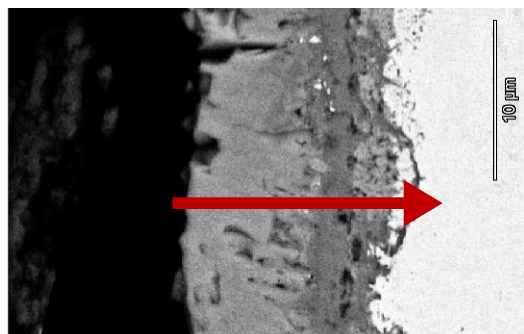


Elements

- Fe
- O
- Cr
- Mg

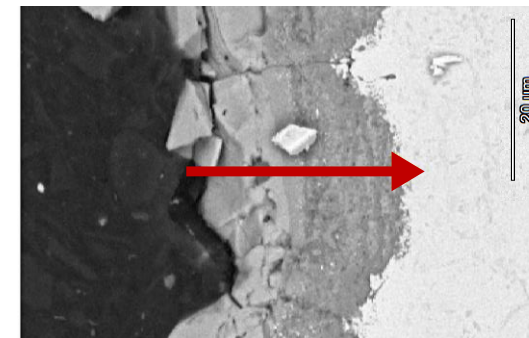
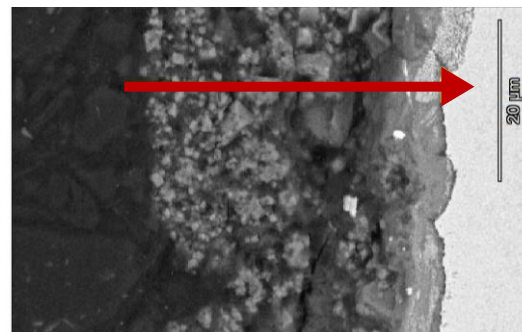
Without doping

SEM/EDS
cross-section

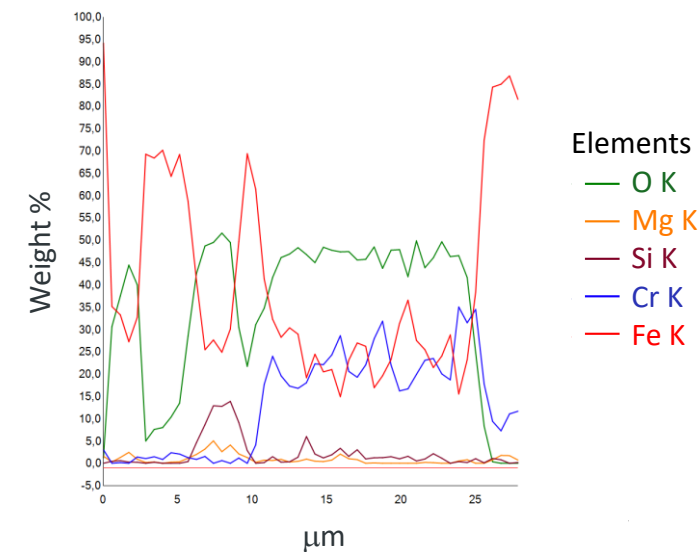
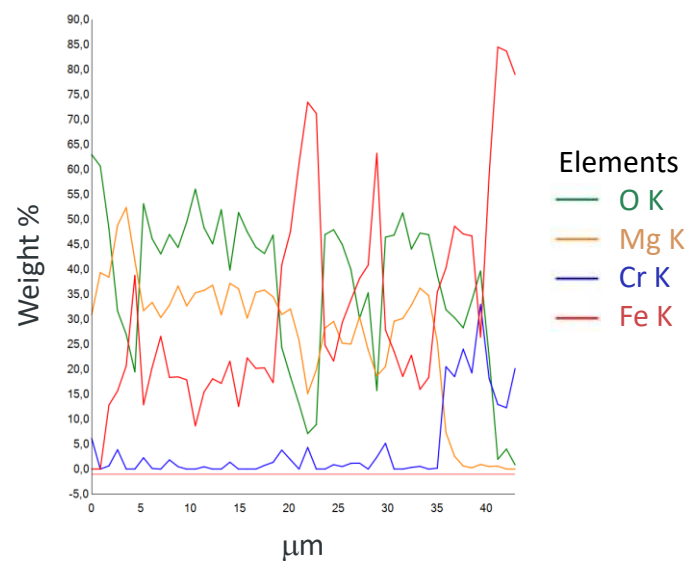
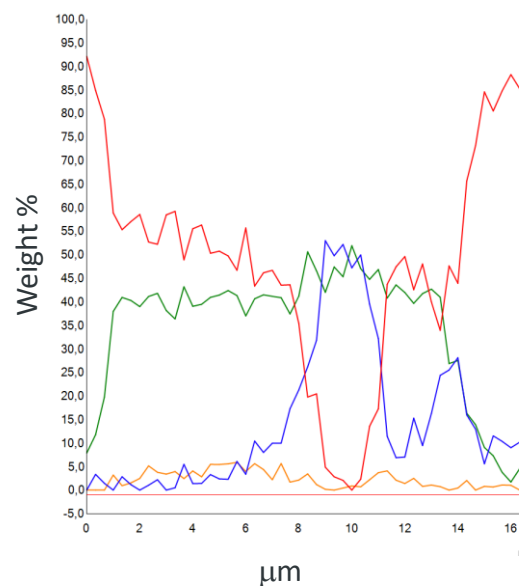


Elements

- O K
- Mg K
- Cr K
- Fe K

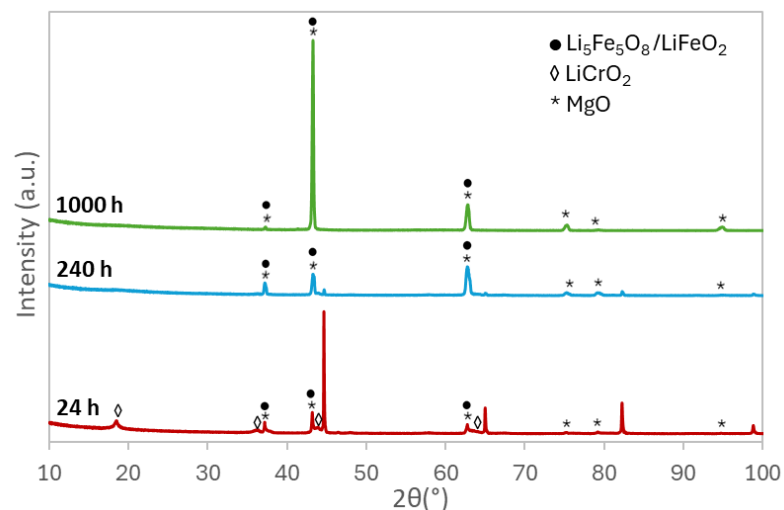


Linescan

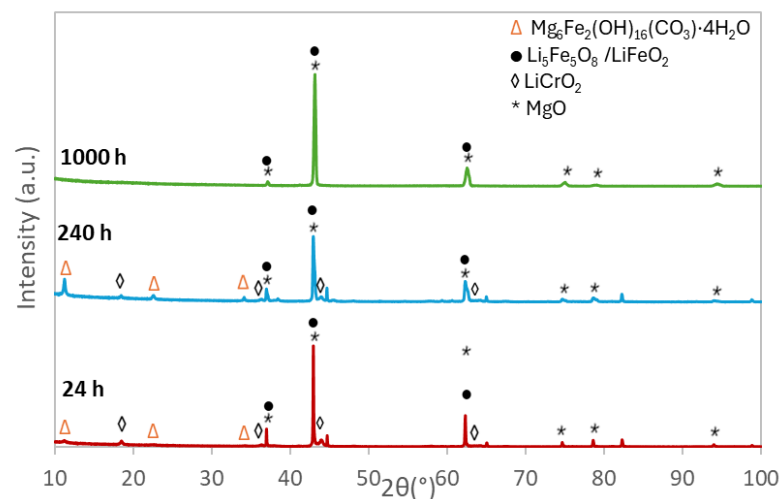


XRD

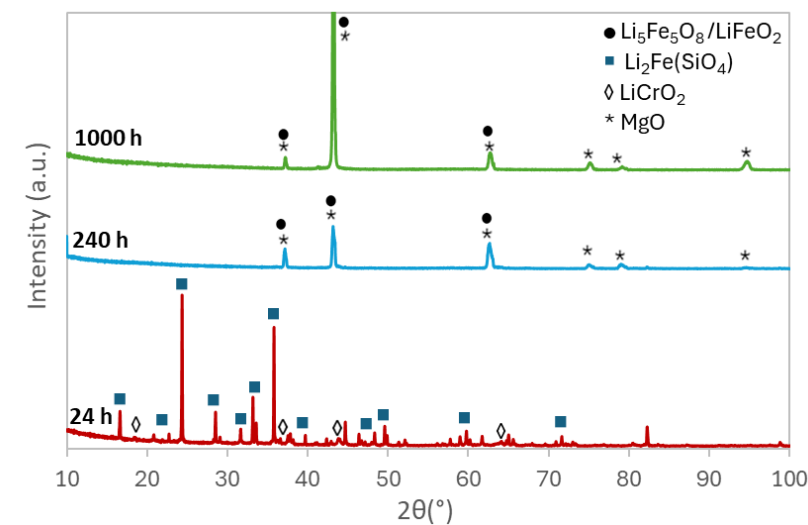
Without doping



MgO



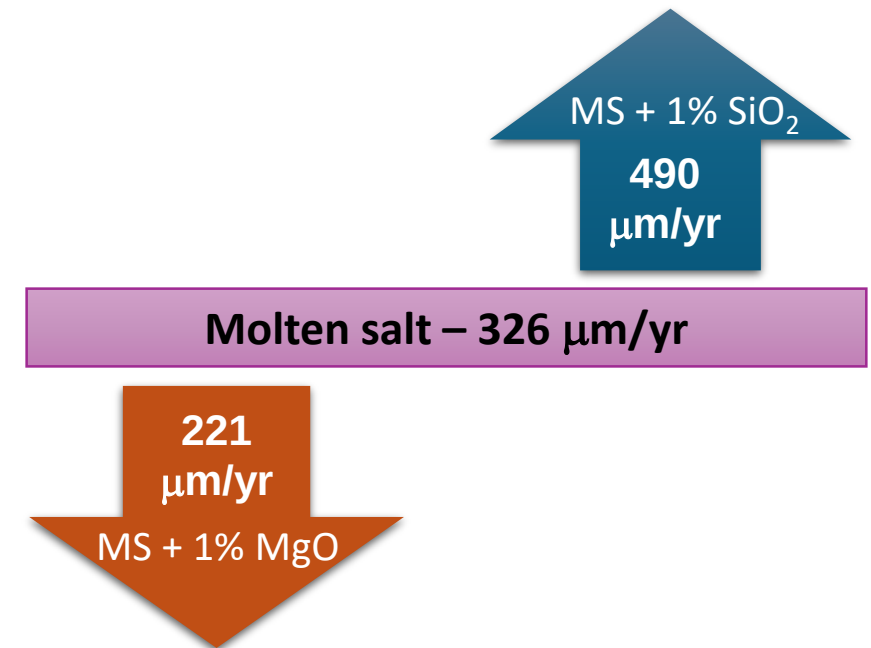
SiO_2



Note: unidentified peaks are from AISI 430

Conclusion

- Different morphologies and multiple oxide layers
- At 1000h the oxides identified: $\text{Li}_5\text{Fe}_5\text{O}_8$ / LiFeO_2 , LiCrO_2 and MgO
- MgO nanoparticles appear to have a significant impact by reducing the corrosion rate of AISI 430 stainless steel
- Which is not the case for silicium oxide
- Currently studying the corrosion mechanisms



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Thank you for your attention!

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