EXPERIMENTS AND MATERIAL

INFLUENCE OF OXIDATION

Cracks depth evaluation:
1. Vp: lateral view
2. Vc: top view
3. a: cracks depth

Crack area

Oxidation decreases thermal fatigue crack initiation life
No clear effect of oxidation on crack propagation rate is observed

INFLUENCE OF INTERMETALLICS Fe-Al

Al pack cementation process:
- Low temperature (500°C) Al-Pack cementation < steel tempering temperature (605°C)
- Al2O3 activator
- FeAl3/Fe3Al scales

Variation of cracks depth vs. Number of thermal cycles under air and inert atmosphere and with or without intermetallics

Development of Thermal fatigue rig in molten metal (Al, Mg, Cu)

Aim:
- To be near industrial conditions
- Control of thermal conditions
- Control of mechanical loading
- To better understand the damage mechanisms of tools

Industrial goals:
- Standard tests development
- Ranking of steel grades

Scientific goal:
- Cracks initiation and propagation modeling

THERMAL CYCLES

THERMAL FATIGUE SPECIMEN

CONCLUSION

Environmental effect on X38CrMoV5 damage was studied:
- Surface oxidation decreases cracks initiation life.
- Cracks initiation in oxide scale result from thermal, mechanical and corrosion coupled loadings.
- Low temperature Al-pack cementation process allows to obtain intermetallic scale on X38CrMoV5 steel with microstructure preservation.
- Iron aluminium intermetallic phases decrease the thermal fatigue crack initiation life of low silicon X38CrMoV5 die steel.

Thermal fatigue tests with high control of temperature cycles allow to rank various steel grades and better understanding of Al molten and thermal fatigue interactions.