Promising TiAlN coating for wear resistance inside LBE

Essam SERAG[1,2], Emile HAYE[2], Ben CAERS[1], Paul SCHUURMANS[1], Stéphane LUCAS[2]
[1]Belgian Nuclear Research Centre, SCK CEN, MOL, Belgium
[2]Namur Institute of Structured Matter, Laboratoire d'Analyse par Réactions Nucléaires, NAMUR, Belgium
E-mail: essam.sadik.serag@sckcen.be

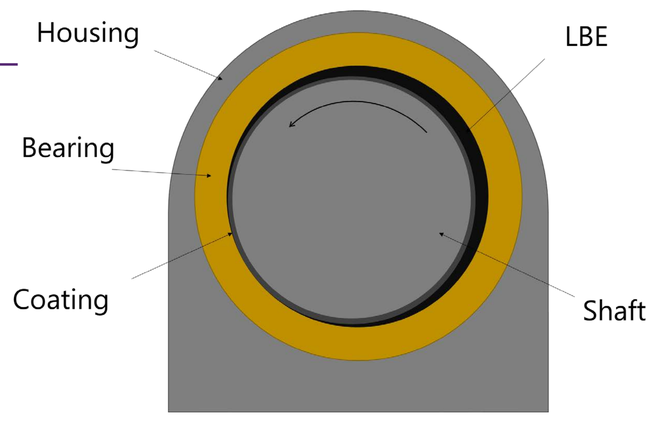
Introduction

- Fuel handling system in MYRRHA will be used mainly to manipulate and inspect fuel.
- The operation of a journal bearing must satisfy two necessary conditions:
  - Complete lubrication of the shaft and bush surfaces by the liquid.
  - Considerable lubricant viscosity.

Both viscosity and wettability of LBE are low and no other lubricant can be used due to lack of suitable sealing material

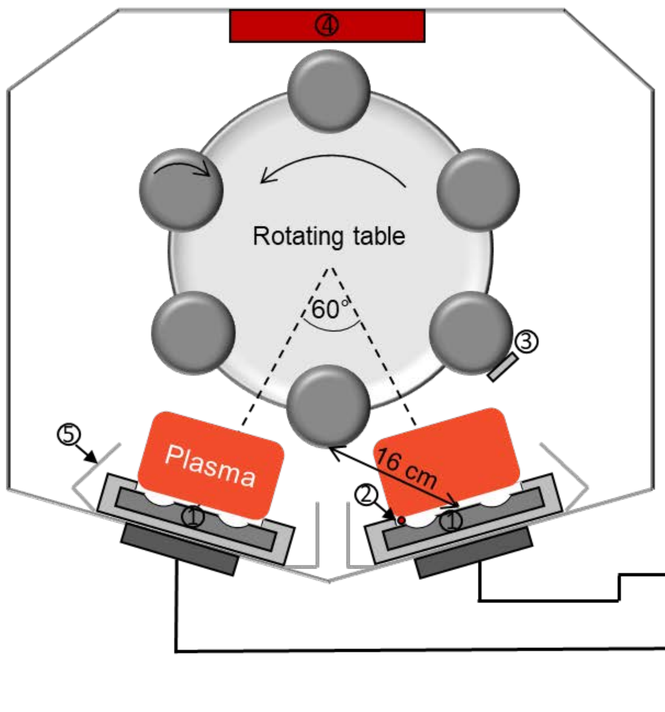
Objectives

- Good adhesion
- High hardness
- Low residual stresses
- Low surface roughness
- LBE compatibility



Materials and Methods

Use of TiAlN coatings deposited by PVD to improve wear behaviour and lifetime of the mechanical component.



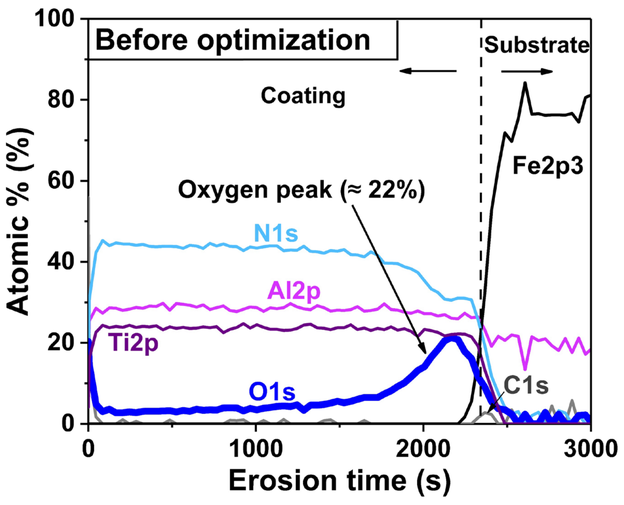
① TiAl targets
② Ar/N2 gas distribution
③ Substrate position
④ Heating element
⑤ Shutters

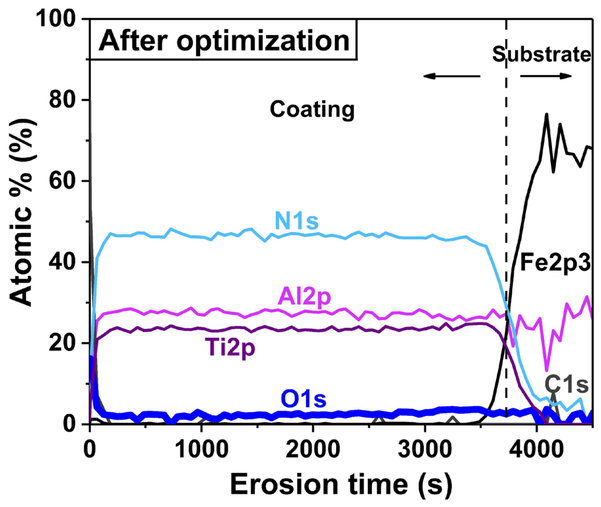
Characterization:
XPS depth profiling, nanoindentation and Rockwell test

Results

Adhesion

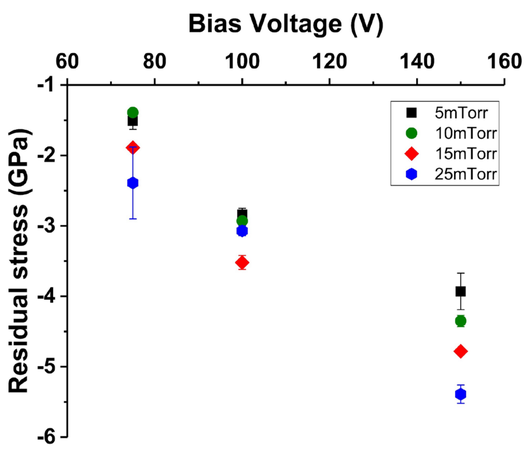
- The presence of oxygen at the interface is detrimental to the adhesion of the coating.
- An etching procedure has been optimized to get rid of interfacial oxygen.

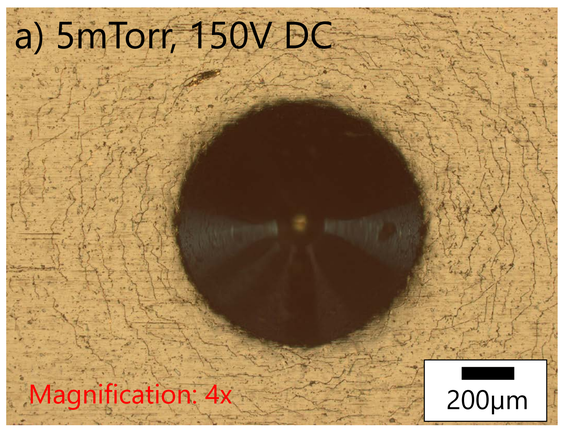


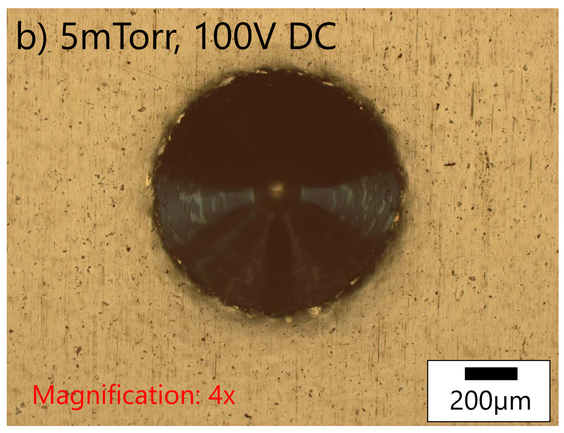


Residual stress

- Increase of compressive residual stresses with the increase of bias voltage.
- Apply 150 kg of load in a Rockwell-C test.
- Higher residual stresses promote crack formation.

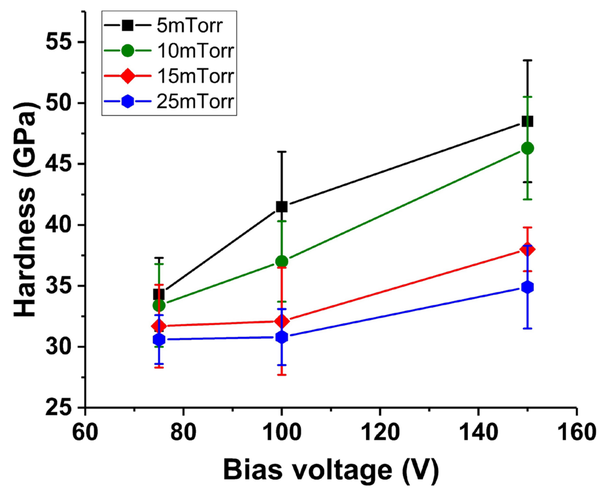






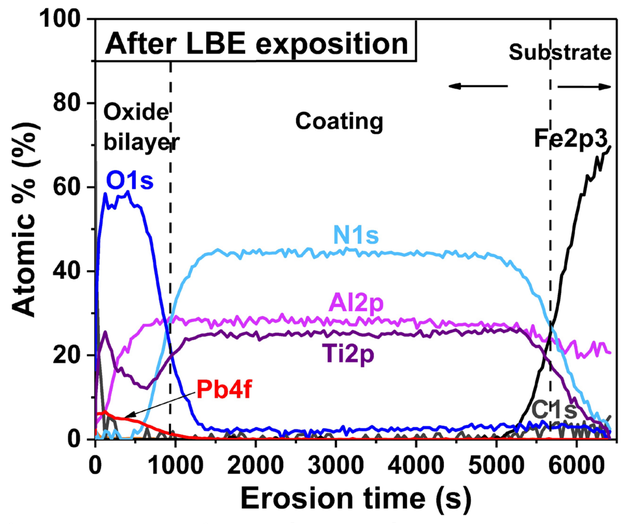
Hardness

- Higher bias voltage and/or lower gas pressure increase hardness.
- Dependence of hardness on bias voltage is less significant at higher pressures.



LBE immersion

- Static LBE test:
  - 400°C
  - Saturated C_{O2}
  - 500h
- Formation of $TiO_2/Al_2O_3+TiO_2$ bilayer on the surface of the coating:
  - Thickness ≈150 nm
  - Traces of Pb (PbO?)
- The coating keeps its integrity protecting the substrate.



Conclusion & perspectives

- Optimization of the etching and deposition processes.
- LBE test proves the compatibility of TiAlN coating with LBE.
- Oxidation kinetics and mechanisms are under determination.
- Testing coated shafts against wear inside LBE will be considered as a next step.

Acknowledgments

SIAM platform from UNamur is acknowledged for XPS facilities.

Exploring
a better tomorrow
www.sckcen.be