

:A process evaluation of the first kind:

Jaydeep Joshi, Ashish Yadav, Arun Kumar Chakraborty, Hitesh Patel, Mahendrajit Singh

ITER-India, Institute for Plasma Research, Gandhinagar

jaydeep.joshi@iter-india.org



ABSTRACT

- During the performance testing- Hot Helium Leak Test at 150 C and >25bars, for one of the accelerator grid for Diagnostic Neutral Beam (DNB), a failure across the Electrodeposited (ED) water to vacuum boundary was observed.
- This happens to be the first instance where an ED bond has been subjected to such severe test as per ITER spec. and this failure has triggered the necessity to undertake a systematic evaluation study to assess and establish the adhesion characteristics of such bonds, especially at operational temperature.
- Multiple ED samples, drawn from different ED bath, have been subjected to a specially designed test procedure, along with the other conventional mechanical and metallurgical tests, in order to arrive at an assessment of the strength parameters for the bond.
- Hence, the present study is purported to present itself as a procedure for evaluation of this important manufacturing process. This is possibly first such initiative of its kind.

BACKGROUND

Configuration of the 'angled' PG segment of DNB Source (Right picture shows the c/s of cooling channels, to be closed by ED)

'As manufactured' angled PG segment
Failure during the Hot Helium Leak Test (150 C and >25bars) of Plasma Grid Segment of DNB (Right Picture shows the separation of ED layer from the base plate)

CHALLENGES / METHODS / IMPLEMENTATION

Challenges

No recommended procedure / historical database for carrying out an assessment of the bond integrity for electrodeposited surfaces and also no codes are presently available to qualify the process compatibility for the operational requirements including application at around 150 C.

Methods

- Adhesion Strength:
 - Push Test and Modified Ollard Test
- Hardness measurement
- Optical Microscopy
- Immersion Ultrasonic Testing
- All deposited sample tensile testing

Implementation

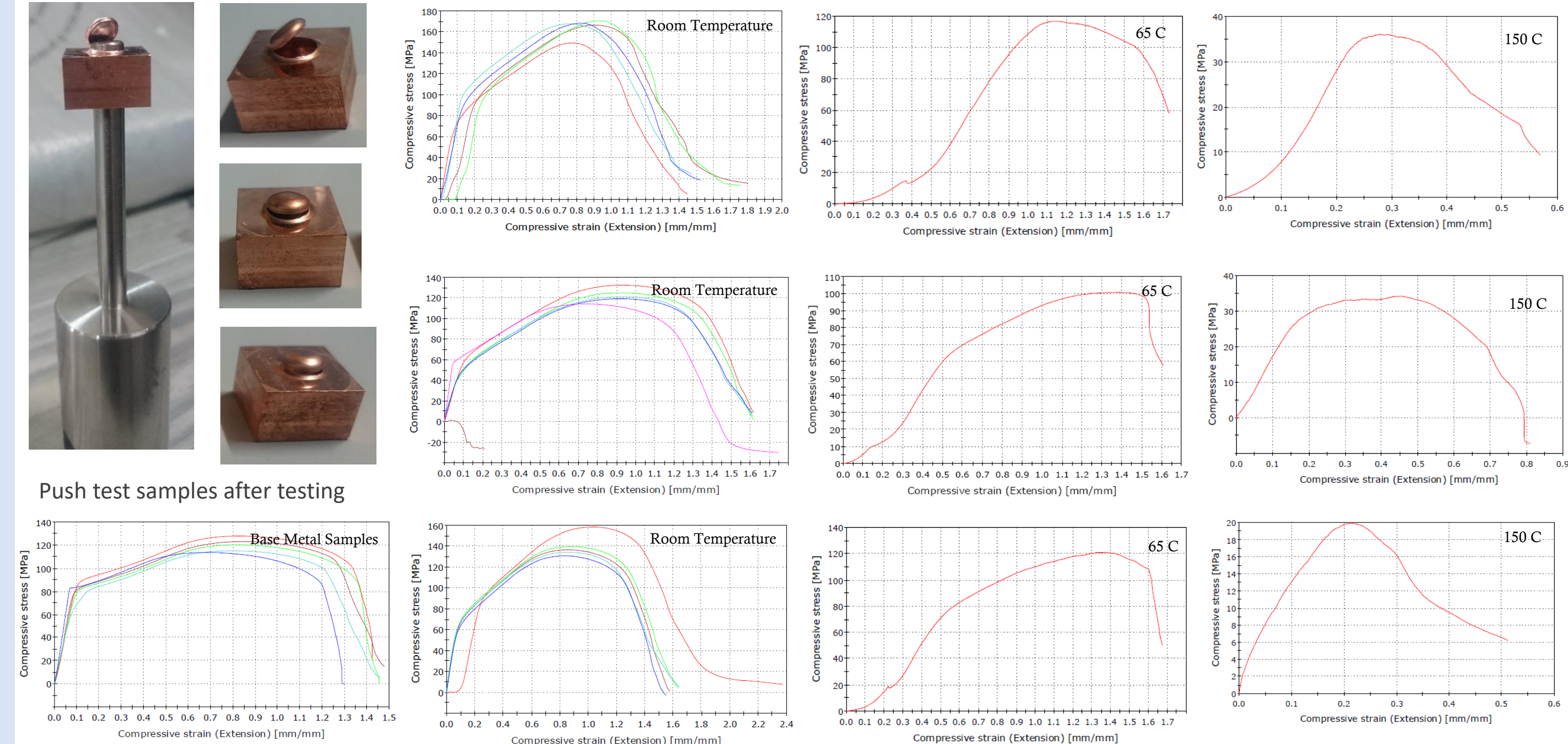
Adhesion test: customised Push Test

Adhesion test: Modified Ollard test

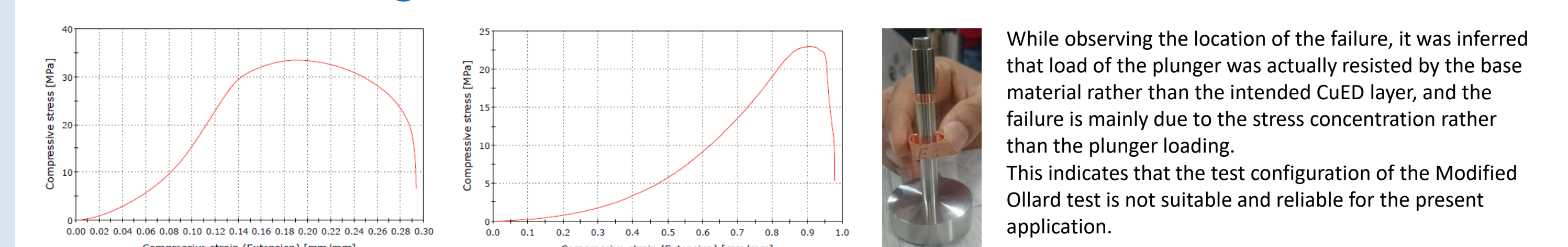
Test in-progress on Universal Testing Machine

OUTCOME

Adhesion strength- Push test



Adhesion strength- Modified Ollard test



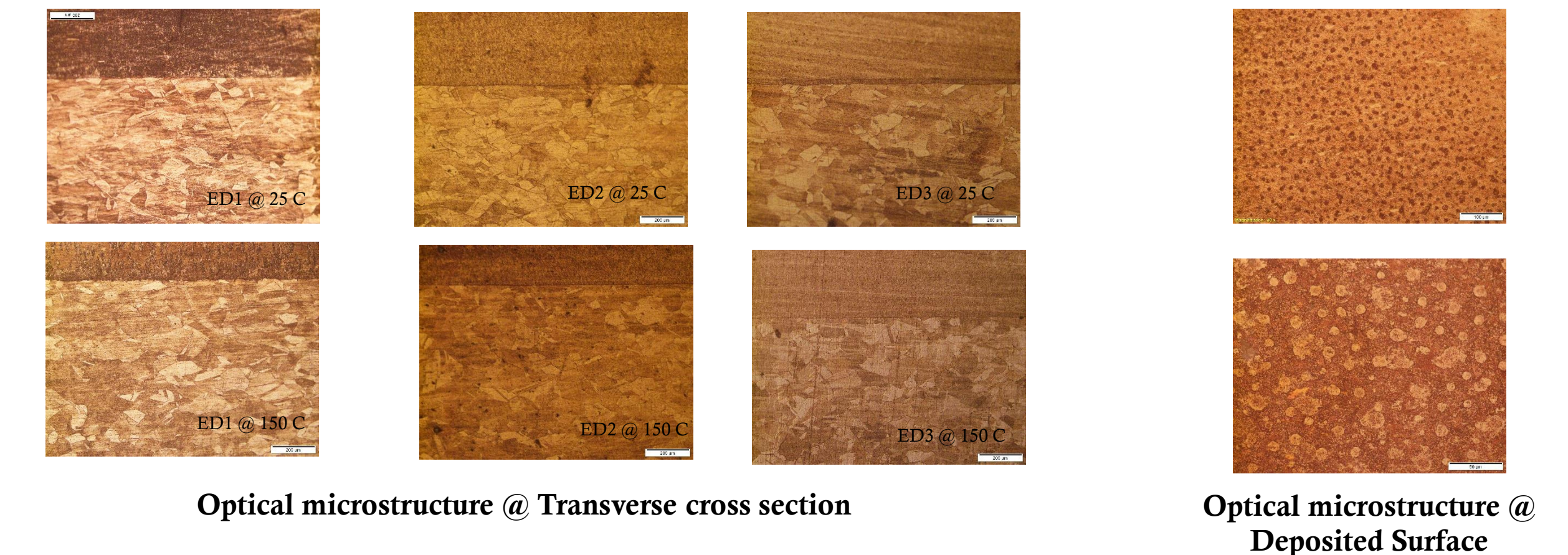
Hardness profiles



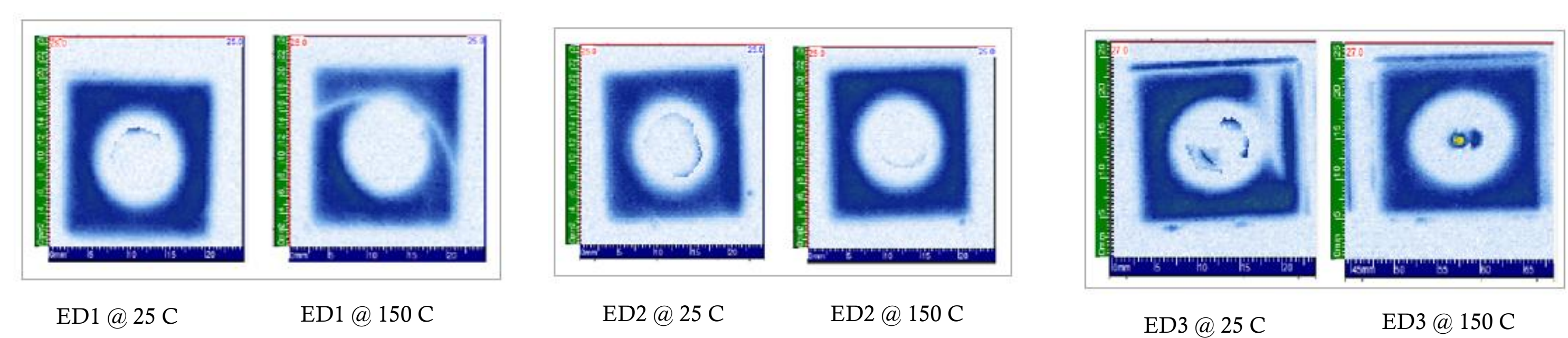
'All deposited' tensile strength

Electrolyte	25 C	150 C	150 C	150 C	150 C
ED 1	235	176	184	180	185
ED 2	304	214	217	221	218
ED 3	304	220	220	223	219
Raw Material	290	238	245	242	

Metallurgical investigation



Immersion Ultrasonic Examination



SUMMARY

- A process has been established in form of experiments where ~20 samples, from different baths, have been subjected to tests to evaluate and obtain a statistical variation in the quality of the bond at room as well as at elevated temperature of 150 C.
- Test results shows the variation in the bond strengths is highly dependent on the bath quality
- The results also establish that (1) it is mandatory to qualify the ED process according to the functional parameters and (2) it is equally important to qualify EACH bath, to ensure a reliable application of ED process for the actual components.
- Recommendation of the qualification process is as follows; (1) carrying out and interpreting the specially designed push test for samples (2) Co-relating the strength with the hardness parameters (3) study of microstructural characteristics and (4) application of process on production pieces.

ACKNOWLEDGEMENTS

- Support from M/s PVA Industrial Vacuum Systems, M/s Research Instruments, Germany and their sub-suppliers, in terms of providing the samples is sincerely acknowledged.
- Support from HHFT and TBM group of IPR for providing the facilities for adhesion testing and immersion ultrasonic testing is sincerely acknowledged.