CSIR INDUSTRY MEET

Theme- Technologies for Aerospace, Electronics, Instrumentation & Strategic Sectors

TECHNOLOGIES DEVELOPED

BY

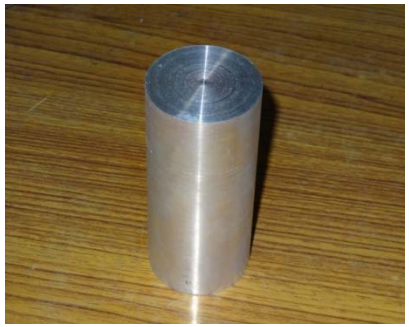
CSIR-NATIONAL METALLURGICAL LABORATORY,

JAMSHEDPUR – 831007

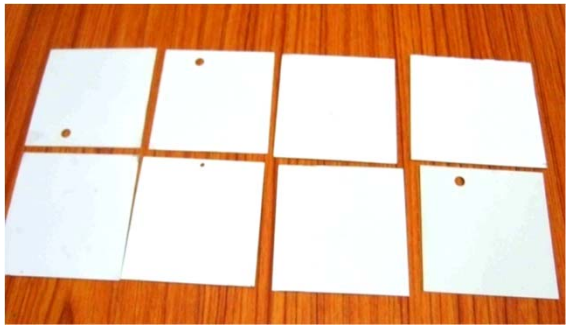
INDIA

ENVIRONMENT FRIENDLY LOW EMBRITTLEMENT COATINGS TO REPLACE CADMIUM

- Al & Al alloy coatings by sputtering (Target to coating and its evaluation)
- Al coatings by electrodeposition route using ionic liquid
- Compositionally modulated multi-layered Alloy (CMMA) coatings

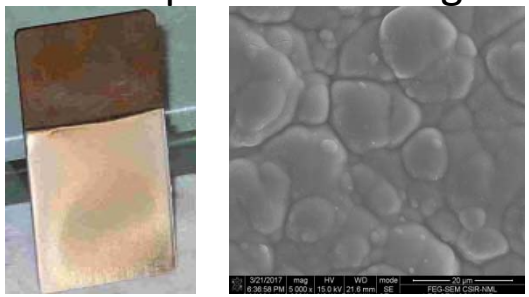


Al-Alloy Ingot

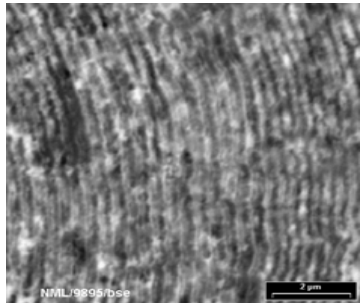


Sputter deposited coating

Electrochemical set up



Al-Coating by EC route



CMMA Zn-Fe Coatings

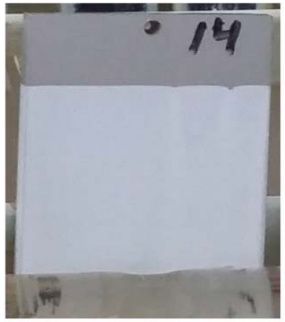
TRL-3

CHROMIUM FREE COATING FOR 2024 ALUMINIUM ALLOY

Presently Cr (VI) is used as conversion coating for corrosion protection of Al-Alloy

- CSIR-NML has developed Cr free conversion coating for Al-Alloy
- The process is fast and low temperature curable (less than 30 min, less than 80 C)
- Meets the requirements in MIL-DTL-81706 (336 hours of salt spray test and cross hatch adhesion test)

Salt Spray Test

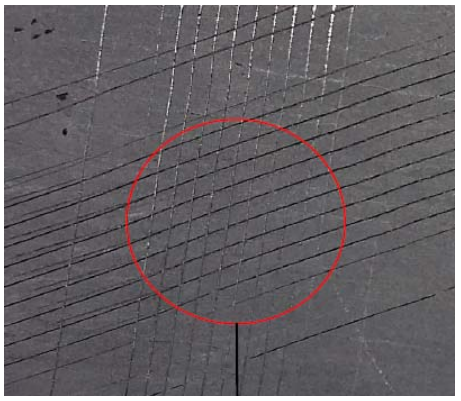


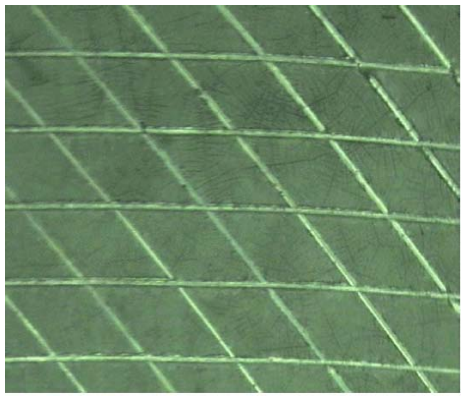
Zero hour

336 hours

1000 hours

Cross hatch test for adhesion





TRL-3

Production of Sodium Metal (Strategic)

- **Pilot Scale**: 3000A close cell operation at M/s SRHHL, Kurnool
- **Features**
  - Scale- up design, fabrication of 3000A cell based on NML's 500A cell
  - Commissioning of 3000A cell at Kurnool
  - Purity of sodium metal 98.7 - 99.8%
  - Current efficiency 75 – 80%

Sodium Pilot Plant

3000A cell

Sodium Collection

Sodium Metal

Production of sodium hypo chloride with chlorine gas

- **Commercial Scale:** At M/s SRHHLK, Kurnool, Andhra Pradesh
  - 12000A cell will be commissioned at M/s SRHHL, Kurnool
  - Aimed production capacity: 2 ton per day

TRL-9

Production of Gadolinium Metal (Strategic)

Design, fabrication & operation of NML's 100A close cell

❑ Process

- Molten salt electrolysis of $GdCl_3$
- Deposition of Gd powder at cathode
- Preparation of Gd pellets
- Re-melting of pellets in Vacuum Arc furnace

Electrolysis Parameters

- Design of close cell,
- operated at 800 – 700^{0}C for 6-8 hrs,
- Bath: Mixed chlorides
- Feed : $GdCl_3$
- Current: 100A, 5-7V
- Efficiency: 40 – 50%

Electrolyser 100A Capacity

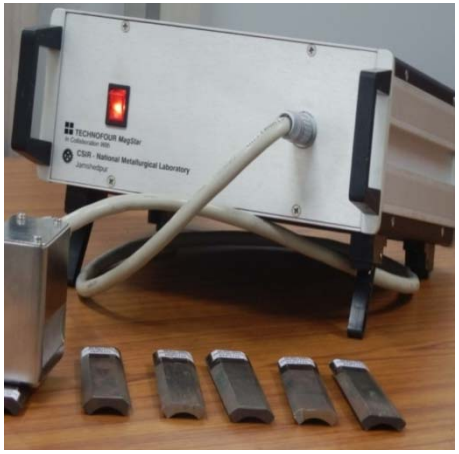
Chlorine gas treatment

As deposited metal

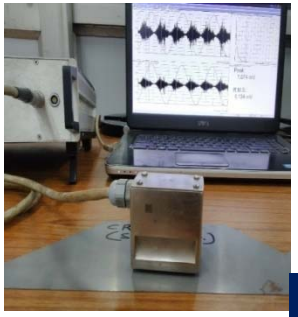
TRL-7

Sensors & Devices for Structural Health Monitoring

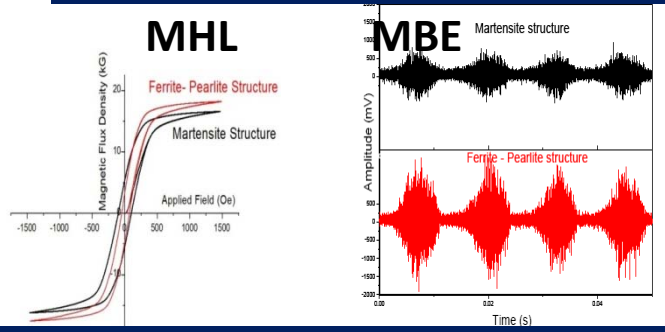
MagStar is a portable electromagnetic sensing device for Non-destructive evaluation of steel structure/components. Sensor probe head is used for magnetic excitation and flux pick up from the test object to generate Magnetic Hysteresis Loop (MHL) and Magnetic Barkhausen Emission (MBE) signals.



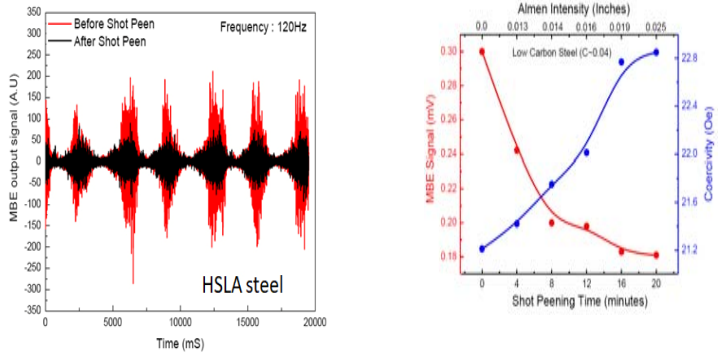
Customized probe for flat and curved surfaces



Phase evaluation of ferritic steels



Evaluation of Residual Stress



Typical applications of MagStar

- Microstructural phase evaluation of ferritic steels
- Sorting of service exposed CRGO sheets
- Creep damage assessment of boiler tubes / pipes
- Evaluation of residual stress in aircraft landing gear steels (HSLA).

Industrial /Academia users : NTPC-NETRA, JSW (R&D), BARC, IIT-BHU.

Licence Holder : M/s. Technofour, Pune, India

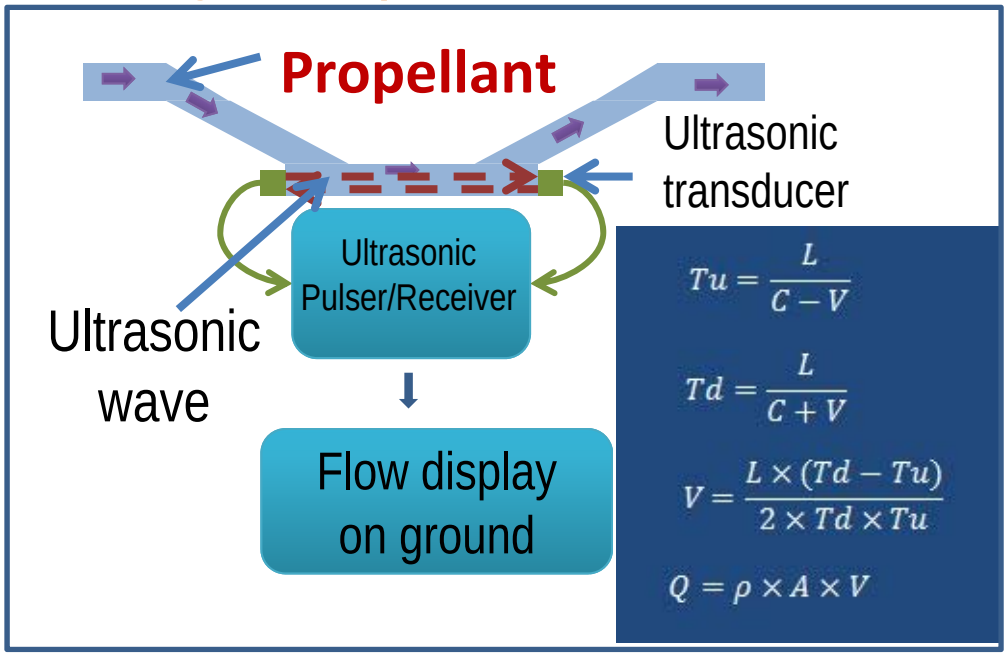
TRL-8

Fluid Flow Gauge: A device for fluid flow rate measurement through narrow tube

- Propellant availability onboard, one of the main factors determining the spacecraft life
- Essential to gauge the propellant accurately for estimation of spacecraft end-of-life (EOL) and to optimize mission strategy

Technology transferred

Working Principle



Salient Features

- Measurement accuracy < 1% from 0.1 LPM to 6 LPM
- Flow Rate Range 0 - 100cc/s (0-6 liters per min (LPM))
- Power consumption < 5W
- Frequency of Pulser: 4 MHz
- Pulser with Two Transmitters fires simultaneously.
- Two Receivers, able to distinguish two received signals (downstream & upstream) with an accuracy of 1ns.

Applications

- On-board End of Life estimation of Spacecraft
- Fuel estimation of aero engines
- As a Gas flow meter

TRL - 7

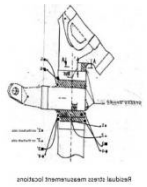
Our Client

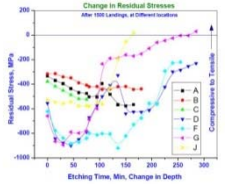
Recent Activities on Failure Investigation & Life Extension of Aircraft Components at CSIR-NML: A Glimpse

Life Extension Programme of Mig-29 Aircraft Main Landing Gear (Indian Air Force)

Scope:

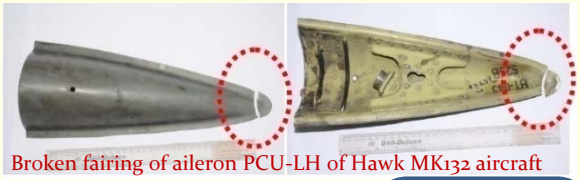
- Assessment of comprehensive residual stress on four MLGs by X-ray Diffraction (XRD)
- Identify critical locations based on relaxation residual stress
- Find a parameter having correlation with the fatigue life



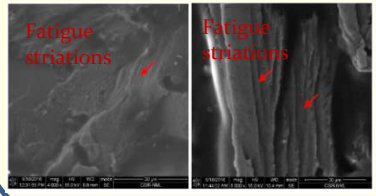


The stress profile exhibits both tensile and compressive nature with variable trend depending on sampling location

Failure analysis of aileron PCU failed ring of HAWK MK 132 aircraft

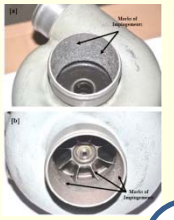


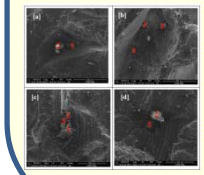
Broken fairing of aileron PCU-LH of Hawk MK132 aircraft

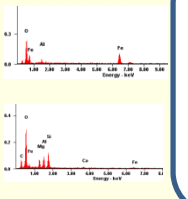


- Fairing was broken due to fatigue.
- Fatigue occurred owing to loose fitting of component, which caused knocking of the fairing against the wing during service.

Failure analysis of turbo coolers of MIG - 21 Bison

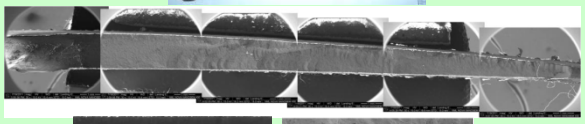


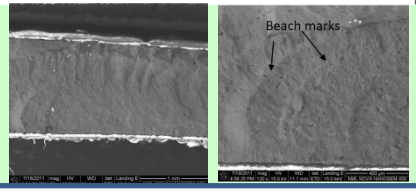




- Turbo coolers were damaged because of erosion (worn-out) of the fan blades, impingement/impact by foreign objects.
- Damages to the rotor shaft, guide wheel and other components of turbo cooler were secondary in nature.
- The embedded foreign objects were primarily comprising of rocks/sands with elements Si, Al, O, Ca, K, Mg, Na, C, S etc, along with tin, copper and iron.

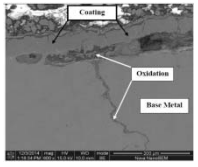
Failure analysis of second stage compressor rotor blades of R13 aero-engine of MIG-21 air craft

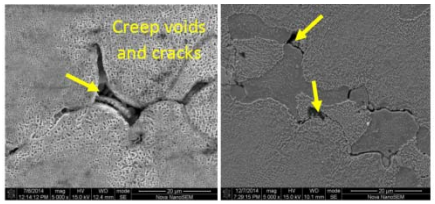




- The blade was made of martensitic stainless steel of Russian grade AE 961W with protective coating over the same
- The failure of the blade was fatigue, initiated from the pits/craters formed on the bare base metal due to impact of sand particles.
- Fatigue crack was propagated from surface during cyclic loading condition i.e. engine off and on, coupled with vibration during flight

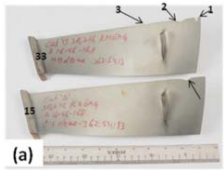
Failure analysis of damaged 1st stage NGV (Nozzle Guide Vane) of R-25 aero-engine.

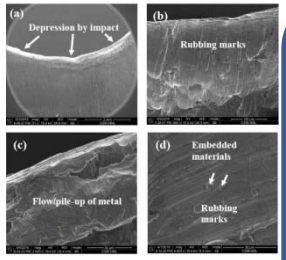




- Composition of NGV's conformed to nickel based super alloy of Russian grade ZC6Y-BE.
- Failure of the 1st stage nozzle guide vane (NGV) was due to high temperature oxidation along with creep and thermal fatigue.
- Degradation /damage of coating triggered the high temperature oxidation.
- Cavities/discontinuities during creep provided the easy diffusion paths for oxygen transport accelerating the damage of nickel matrix.

Failure analysis of aero engine damaged blades of SU-30 MKI





- Composition analysis confirmed that the blades were made of titanium alloys (Ti-6Al-4V).
- Microstructure of the blades was consisting of alpha (α) and alpha + beta (α+β).
- Fractography/damaged surface analysis by SEM-EDS confirmed that blades were damaged due to impacts of an iron based metallic object.

Thank You