## 11.2 SELF APPRAISAL REPORT ON TRIBO-CORROSION DAMAGE EVALUATION

### 11.2.1 Contributing Faculty Members

1. Prasanta Sahoo (PS), Mechanical Engineering Deptt., 45 yrs, Journal Publications – 144, Conference Publications – 148, H Index – 14, Total Citations – 665. Awarded and ongoing doctoral thesis guidance – 15 Awarded and ongoing Masters thesis guidance – 22

2. Tapan Kr. Barman (TKB), Mechanical Engineering Deptt, 32 yrs, Journal Publications – 15, Conference Publications – 38, H Index – 3, Total Citations – 38. Awarded and ongoing doctoral thesis guidance – 2 Awarded and ongoing Masters thesis guidance – 2

### 11.2.2 Special Achievements

**P. Sahoo** has been appointed Associate Editor in International Journal of Materials Forming and Machining Processes (IJMFMP), IGI Global

**P. Sahoo** has been appointed **Member, Editorial Board** :Materials & Design (Elsevier), Journal of Tribology and Surface Engineering (Nova Science), International Journal of Pure and Applied Sciences and Technology , International Journal of Materials, Manufacturing and Mechanical Engineering (IJMMME) (IGI Global), International Journal of Surface Engineering and Interdisciplinary Materials Science (IGI Global), ISRN Tribology (Hindawi), Indian Journal of Material Science (Hindawi)

**P. Sahoo** has been appointed Member (UGC Nominee), Advisory Committee, UGC-SAP, Mechanical Engineering, Indian Institute of Science, Bangalore

### 11.2.3 Relevant Projects in Last 10years including the Ongoing Projects

| Project Title | Sponsoring Agency | Members | Grant Value (Rs in Lakh) | Duration |
|---|---|---|---|---|
| High Temperature Tribology of Materials | TEQIP-II (COE) | PS (PI) | 45 | 2013-15 |
| Experimental Investigations of Tribological and Mechanical Properties of Fibre Reinforced Composites | UGC | NM (PI) PS | 12.75 | 2013-16 |
| Tribology of electroless nickel coatings | UGC | TKB (PI), PS | 10.66 | 2012-15 |
| Tribology of electroless nickel boron coatings | CSIR (SRF) | PS, SKD (SRF) | 4.2 | 2009-11 |
| Investigation on large displacement static, dynamic and stability behaviour of stiffened plates | AICTE (NDF) | PS, KS, AM(NDF) | 8 | 2009-12 |
| Corrosion testing | MHRD | PS | 8.5 | 2009 |
| Material Testing for Mechanical Properties | DST (PURSE) | PS, SA, SB(SRF) | 33 | 2010-13 |

| | | | | |
|---|---|---|---|---|
| Roughness characterization of machined surface topography and the effect of process parameters | UGC (RGNF) | PS, TKB(SRF) | 4 | 2005-08 |
| Development of facility for Tribological Testing | TEQIP-JU | PS, AC, SKG | 20 | 2004-09 |
| Development of facility for surface roughness measurement | DST-FIST | PS | 5 | 2000-05 |
| Fractal characterization of machined surface topography and the effect of process parameters | DST | PS | 2.88 | 2004-07 |

### 11.2.4 Relevant Publications in Last 5 years


Roy, S. and Sahoo, P., Optimization of electroless Ni-P-W coatings for minimum friction and wear using Grey Taguchi method, Journal of Coatings, 2013, ID 608140, 1-13.

Roy, S. and Sahoo, P., Tribological performance optimization of electroless Ni-P-W coating using weighted principal component analysis, Tribology in Industry, 2013, 35(4), 297-307.

Roy, S and Sahoo, P., Corrosion Study of Electroless Ni-P-W Coatings using Electrochemical Impedance Spectroscopy, Portugalie Electrochimica Acta, 2012, 30(3), 203-220.

Das, S. K. and Sahoo, P., Influence of process parameters on microhardness of electroless Ni-B coatings, Advances in Mechanical Engineering, 2012, ID 703168, pp. 1-11.

Roy, S and Sahoo, P., Multiple roughness characteristics of chemically deposited Ni-P-W coatings, Tribology in Industry, 2012, 34 (4), 186-197.

Roy, S and Sahoo, P., Friction performance optimization of chemically deposited Ni-P-W coating using Taguchi method, ISRN Tribology, 2012, ID 136740, 1-9.

Roy, S and Sahoo, P., Optimization of multiple roughness characteristics of chemically deposited Ni-P-W coating using weighted principal component analysis, ISRN Mechanical Engineering, 2012, ID 495857, 1-7.

Roy, S and Sahoo, P., Potentiodynamic polarization behavior of electroless Ni-P-W coatings, ISRN Corrosion, 2012, ID 914867, 1-11.

Das, S. K. and Sahoo, P., Electrochemical impedance spectroscopy of Ni-B coatings and optimization by Taguchi method and Grey relational analysis, Portugalie Electrochimica Acta, 2011, 29(4), 211-231.

Das, S. K. and Sahoo, P., Study of Potentiodynamic Polarization Behaviour of Electroless Ni-B Coatings and Optimization using Taguchi Method and Grey Relational Analysis, Journal of Minerals & Materials Characterization & Engineering, 2011, 10(14), 1307-1327.

Roy, S., Das, S. K., Pal, S. K. and Sahoo P., Friction performance optimization of electroless Ni-P coating, Journal of Tribology Research, Vol 2, No1, 2011, 41-50.

Das, S. K. and Sahoo, P., Fractal characterization of electroless Ni-B coating and optimization of coating parameters, International Journal of Computational Material Science and Surface Engineering 2011, 4(4), 326-346.

Das, S. K. and Sahoo, P., Optimization of Tribological Performance of Electroless Ni-B Coating using Taguchi Method and Grey Relational Analysis, Tribology - Materials, Surfaces & Interfaces, 2011, 5 (1), 16-24.

Das, S. K. and Sahoo, P., A parametric investigation of the friction performance of electroless Ni-B coatings, Lubrication Science, 23 (2), 2011, 81-97.

Das, S. K. and Sahoo, P., Tribological characteristics of electroless Ni-B coating and optimization of coating parameters using Taguchi based Grey relational analysis, Materials and Design, 32, 2011, 2228-2238.

Sahoo, P. and Das, S. K., Tribology of Electroless Nickel Coatings – A Review, Materials and Design, 32, 2011, 1760-1775.

Das, S. K. and Sahoo, P., Characterization of friction behaviour of electroless Ni-B coatings and optimization of coating parameters, Journal of Manufacturing Technology Research, 3(1-2), 2011.

Das, S. K. and Sahoo, P., Roughness optimization of electroless Ni-B coatings using Taguchi method, International Journal of Materials, Manufacturing and Mechanical Engineering, 2011, 1(3), 53-71.

Das, S. K. and Sahoo, P., Optimization of electroless Ni-B coatings based on multiple roughness characteristics, Journal of Tribology and Surface Engineering, 2011, 2 (1-2), 85-106.

Das, S. K. and Sahoo, P., Wear performance optimization of electroless Ni-B coating using Taguchi design of experiments, Tribology in Industry, 2010, 32 (4), 17-27.

Sahoo, P, Wear behaviour of electroless Ni-P coatings and optimization of process parameters using Taguchi method, Materials and Design, 2009, 30(4), 1341-1349

### 11.2.6 Facilities Available

1. Multitribotester (DUCOM, India) procured under TEQIP-I
2. Pin-on-Disc tribometer for lubricated contact (DUCOM, India) procured under UGC MRP
3. Pin-on-Disc tribometer for corrosive environment (DUCOM, India) procured under UGC UPE program
4. Microhardness tester (UHL VMHT, Germany) procured under DST PURSE program
5. Ball on flat reciprocating tribotester (DUCOM, India) procured under UGC MRP.

### 11.2.7 Ongoing Work under UPE II – 2012-14

**Optimization of microhardness of electroless Ni-P coatings using Taguchi technique**

IOSR Journal of Mechanical and Civil Engineering, 2014, 5, 15-19

ABSTRACT: The present paper deals with the synthesis of chemically deposited nickel-phosphorous coatings on mild steel substrate and optimization of the hardness behaviour of the coating. There are several parameters associated with this coating procedure which can affect the hardness of the coating. In this study three coating process parameters are varied within a specific range and various thermal heat-treatment temperatures from 300°C to 500°C were also performed on the coating to obtain the maximum hardness. Thus it is a maximization problem which has been solved using Taguchi L27 orthogonal array design method. ANOVA is performed to

determine the individual significance of parameters and finally a confirmation test is carried out to validate the result.

**Wear behavior of electroless Ni-P coatings in brine solution and optimization of coating parameters**

Procedia Technology, 2014. (Accepted)

Abstract: The present paper studies the wear behavior of electroless Ni-P coating in brine medium and optimization of the coating process parameters for minimum wear using Taguchi method based on L27 orthogonal array. The study is carried out using different combinations of four coating process parameters, namely, concentration of nickel source (A), concentration reducing agent (B), bath temperature (C) and annealing temperature (D). The wear tests are conducted with a pin-on-disk Wear & Friction Monitor. The optimum combination of process parameters for minimum depth of wear is obtained. ANOVA is performed to find out the significance of the coating parameters and their interactions. The surface morphology and composition of coatings are studied with the help of scanning electron microscopy (SEM), energy dispersed X-ray (EDX) analysis and X-ray diffraction (XRD) analysis. It is found that Ni-P coating is amorphous in as-deposited condition but gradually turns crystalline with heat treatment. The worn surface morphology reveals abrasive as well as corrosive wear mechanism.

**Study of Friction Performance of Electroless Ni-P Coatings in Brine Solution and Optimization of Coating Parameters**

Applied Mechanics and Materials, 2014. (Accepted)

Abstract. Friction performance of electroless Ni-P coatings in brine solution is studied and optimization of the coating process parameters for minimum friction is done using Taguchi method. The study is carried out by combination of four coating process parameters, namely, concentration of nickel source, concentration of reducing agent, bath temperature and annealing temperature. The friction tests are conducted with a pin-on-disk friction monitor. The optimum combination of process parameters for minimum coefficient of friction is obtained. ANOVA is performed to find out the significance of the coating process parameters and their interactions. The surface morphology and composition of coatings are studied with the help of scanning electron microscopy (SEM), energy dispersed X-ray (EDX) analysis and X-ray diffraction (XRD) analysis.

### 11.2.8 Work plan during 2014-17

To study the tribological characteristics (mainly friction and wear) of electroless nickel phosphorous coatings under different corrosive environments like acidic medium ($H_2SO_4$) and alkaline medium (NaOH). The microstructure, composition and phase structure of the coatings both as-deposited and corroded (under different environments) will be studied and attempts would be made to relate these with their tribological characteristics. The roughness structures and hardness will also be evaluated to observe the degradation due to corrosive environments. Attempts will also be made to optimize the coating parameters as well as the tribological test parameters for lower friction and wear characteristics of the coatings.