

## **DR. RAMESH CHANDRA AGARWALA**

### **Area of Research:**

**Nanocomposites coatings by Electroless Technique,  
Phase transformation studies etc.**

**Employee code, IIT Roorkee -** 80111

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**Date and Place of Birth** : 7<sup>th</sup> July,.1947, Muzaffarnagar(UP)India.

### **Academic Qualification** :

**Bachelor of Engineering** (Metallurgy), National Institute of Technology, Nagpur, India, 1973  
(Awarded Merit Scholarship, 1970-73. Nagpur University Rank holder).

**Master of Technology** (Physical Metallurgy), Indian Institute of Technology, Kanpur,1975  
(Awarded prize on 11<sup>th</sup> National Metallurgists' day for the Essay on Research Work)

**Ph.D.**(Met. Engineering), Indian Institute of Technology Roorkee, 1985  
(Area of research Structural Studies and Crystallization behaviour of Electroless Ni-P Films. The work is referred in Surface Engineering books)

### **Details of overseas visit** :

Appointed as Head, Metallurgical and Materials Engg. Dept., Federal University of Technology, Akure, Nigeria -various Research Projects got sanctioned for the department during the tenure (April 1994 - April 95).

### **Awards/ Membership**

- Merit Scholarship (1970-73)
- Nagpur University Rank holder,6, (1973)
- Awarded prize in the 11<sup>th</sup> National Metallurgist Day for the essay on Research Work (1974).
- Faculty member "Technical exchange programme" on Non-Destructive Testing, BHEL, Hardwar, Dec.1980- Feb.(1981).
- Elected as Member of Municipal Board, Roorkee through general elections in1988 –Municipal Commissioner during (1989-Jan '94)
- Member, Technology Watch Group for Automobile Industries, AICTE (1997-98)
- Facilitator, SURA award on material for space applications, UOR (2001)
- Life member, Indian Society for Continuing Engineering Education

- Member, ABI, American Biographical Institute, Inc's RESEARCH BOARD ADVISOR, (2002).

**Patent:**

Filed patent on electroless Ni-P-ZrO<sub>2</sub>-Al<sub>2</sub>O<sub>3</sub> composite coatings through CSIR lab. No.100/Del/2001, gazette of India, part III-sec. 2, May 19 (2001): Co-precipitation of alumina- zirconia followed by co-deposition having Nanostructured coatings for wear & satellite application..

**Convener :**

Institute Industry Interaction Meet on 'Metal Matrix Composite Bulk & Coatings, held at Metallurgical and Materials Engineering, UOR, Roorkee, (Oct.1999).

**Employment Record:**

S. No.	Name of the Institution	Period	Designation	Nature of responsibility
1	I.I.T., Kanpur	July1974- June76	Junior Research fellow	Research & UG Labs.
2	I.I.T., Roorkee	July 1976 – Jan.90	Lecturer	Teaching & Research.
3	I.I.T., Roorkee	Feb. 1990 -92	Reader- Grade	Teaching & Research.
4	I.I.T., Roorkee	Nov. 1992 to March 1994 & May1995 onwards	Reader-Cadre as above Assistant Prof. Associate Professor	Teaching, Research Administration
5	Federal Univ. of Technology, Adore Nigeria	April 1994 - April 95	Appointed as acting Head, Department of Met. & Materials Engg.,	Teaching, Research & Administration.

**National / International Collaboration:**

CSIR, Regional Research Lab., Thiruvananthapuram  
Non Ferrous Technology Development Center, NFTDC, Hyderabad  
MREC, Jaipur  
Royal Institute of Technology, KTH, Stockholm, Sweden

**Teaching Experience -1976 onwards:**

**Courses** handled for the **UnderGraduate and Post-Graduate students** of Metallurgical and Materials Engg. and Mechanical Engineering, Electrical and Industrial Engineering .

**Subjects** being handled are Phase transformation, Materials Science, Non destructive testing, Diffusion in solids Metallurgical Anal

**Field of Research Work:**

- On thermodynamics of Pb-Bi alloys & Ternary Alloys by EMF Technique (1973-76).
- On the reaction annealing on Copper-Tin-Copper-Niobium composites (1977 - 1982).

- On Electro Less Ni-B, Ni-P, Ni-P-X ( X= Al<sub>2</sub>O<sub>3</sub>, Graphite, Al<sub>2</sub>O<sub>3</sub>. ZrO<sub>2</sub> , Ferrites) coatings - Surface Engineering studies 1982 onwards.
- Studies on aluminides like Ni<sub>3</sub>Al & TiAl with and without the alloying additions and the subsequent study on their mechanical properties with various heat treatments and mechanical forming 1990 onwards.

### **Research Projects Undertaken & Reports Submitted:**

1. Influence of copper on the catalytic activity of aluminium substrate for electroless deposition. UP CSIR, (1983-84).
2. Study on the kinetics of crystallisation of amorphous Ni-B deposits on copper substrate. UP CSIR, (1984-85).
3. Electroless Ni-P Deposition & Crystallisation behaviour. UP CSIR, (1984-85).
4. Plating of Ni-P alloy as composites by electroless plating. UP CSIR (1988-89).
5. Mechanical Properties of composite materials obtained by electroless techniques,UP CSIR, (1990-91).
6. Effect of electroless Ni-P deposit on the wear characteristics of leaded aluminium alloy,UP CSIR, (1991-92).
7. Graphite Matrix interface study of aluminium composites containing rare earths, UP CSIR, (1992-93).
8. Development of aluminides like Ni<sub>3</sub>Al with and without suitable alloying addition CSIR, (1991-94).
9. Wear characteristics of leaded aluminium MMC - UGC, (1994-96).
10. Effect of Mechanical and Thermomechanical treatment of TiAl and Ni<sub>3</sub> Al like Aluminides, DST, (1996-99).
11. Principal Investigator, Technology Watch for Automobiles Industries, AICTE, (1997-98).
12. Quality Upgradation for Honda model pistons, Sriram Pistons, 2 Rings, GZD, (1998).
13. Minor research project on “Development of nickel based composite coatings”, UGC grants of UOR, Roorkee, (2000-2001)
14. Failure analysis of KTPSB-unit No 5 Eco tubes, APGENCO, Vidyut Saudha, Hyderabad, (2002).
15. Failure analysis of Boiler tube-advanced metallography studies of pressure vessel, NTPC, New Delhi, (2002).
16. Material development analysis for rings, Sriram Pistons & Rings, Ghaziabad, (2002).
17. Synthesis and Characterisation of iron/nickel based Nanomaterials using gas reduction and coating techniques, DST, Rs.17, 65, 200/- (2003 onwards).

### **Thesis Supervised**

#### **M.E. / M. Tech.**

1. A study of the kinetics of growth of Nb<sub>3</sub>Sn in a Cu-Sn-(Cu-Nb) composite, (1981)
2. Problems of Indian Low Alloy Steel, (1984)
3. Mechanical Behaviour of rheocast leaded aluminium alloy, (1991)
4. The effect of ageing in wear characteristics of the rheocast leaded aluminium alloy, (1992)

5. An interface study of the graphite and aluminium alloy matrix, (1997)
6. Comparative study of SS wires reinforced alloy matrix with S.G. wire cast iron used for automobiles industry, (1997)
7. Design and fabrication of graphite reinforced composite, (1998)
8. Development of quality assurance system in metal forging industry, (2000)
9. Optimization of coating techniques for Surface Engineering applications, (2001)
10. Development of Al-TiC in-situ composite, (2002)
11. Dev. of Ni-P-X composite coatings for satellite applications, (2002)

M. Phil/ Ph. D.

1. Characterisation of Electroless silver platings, (1990)
2. Synthesis and Characterisation of Al-Gr composite, (1999)
3. Wear characteristics of Al-Pb alloy, (2001)
4. Electroless Ni-P composite coating, (2002)
5. TMT of TiAl with suitable solutes, (2003)

## LIST OF PUBLICATIONS

### International level

1. P.K. Ghosh, S. Ray and **R.C. Agarwala**, "Reaction annealing of copper-tin-copper-niobium composite", of Mat. Sc., Letters 3, 370-374 (1984).
2. **R.C. Agarwala** and S. Ray, "Variation of structure in Electroless Ni-P Films with Phosphorus Contents", Z. Metallkunde Bd. 79, 472-475 (1998).
3. **R.C. Agarwala** and S. Ray, "TMT investigation of the transformation during Annealing in Electroless Ni-P Films". Z. Metallkunde Bd. 80, 556-562 (1989).
4. **R.C. Agarwala** and S. Ray, "Crystallisation Behaviour of Ni-P Electroless Deposits : Part I Magnetic moment study, Z. Metallkunde 83,3, 199-202 (1992).
5. **R.C. Agarwala** and S. Ray, "Crystallisation behaviour of Ni-P Electroless Deposits : Part II Kinetic study, Z. Metallkunde 83,3, 203-207 (1992).
6. Anita Srivastava, Sunil Mohan, V. Agarwala and **R.C. Agarwala** "Hot stage TEM study on the crystallisation behaviour of Ni-17.8 Belectroless deposit", Z. Metallkunde 83, (1992)4, 254-257.
7. Anita Srivastava, Sunil Mohan, V. Agarwala and **R.C. Agarwala**, "Factors influencing the deposition rate of Ni-B Electroless Film, Z. Metallkunde 83, 251-253 (1992)
8. Rajneesh Garg, S. Mohan, V. Agarwala and **R.C. Agarwala**, "Wear characteristics of rheocast leaded aluminium Metal- Metal composite", Z. Metallkunde 84, 721 (1993).
9. S.K. Srivastava, S. Mohan, V. Agarwala and **R.C. Agarwala**, "The effect of ageing on wear characteristics of rheocast leaded aluminium alloys", Met. Trans. A Vol. 25A, No. 4, 851 (1993).
10. S.K. Srivastava, S. Mohan, V. Agarwala and **R.C. Agarwala**, "Ageing in rheocast leaded aluminium alloys", Z. Metallkunde 95, 513 (1994).

11. P. Rajeev, V. Agarwala, **R.C. Agarwala** and S. Mohan "High temperature deformation characterisation of TiAl - An empirical model study", Berg- Hutten. Mon.141, 122 (1996).
12. P. Rajeev, V. Agarwala, **R.C. Agarwala** and S. Mohan "Mathematical modelling for high temperature deformation characteristics of Ti – 50% at /Al intermetallics Berg- Hutten. Mon. 142, 1-6 (1997).
13. Lalit Mohan Garg, V. Agarwala and **R.C. Agarwala** "Production of Stainless steel wires Reinforced Al-base Alloy", Berg-Hutten. Mon, 143, (1998)
14. Lalit Mohan Garg, V. Agarwala and **R.C. Agarwala** "Effect of heat treatment on the mechanical properties SS wire reinforced Al only matrix" AAI, INCAL, Feb.10-12 (1998)
15. V. Agarwala, **R.C. Agarwala** and K.G. Satyanarayana, "A study on the development and wear characteristics of rheocast Al-5Cu/Pb-18Sn wire composite" Materials Science & Engineering A, Materials Science & Engineering A,327,186-202 (2002).
16. V. Agarwala, **R.C. Agarwala** and K.G. Satyanarayana, "Development of aluminium alloy by reinforcing with mild steel wires", Material Science and Engg.A, p12, (1999).
17. **R.C. Agarwala**, V. Agarwala and Punit Kumar, "Effect on TMT on recrystallisation of Ni3Al" Intermetallics 8 85,(2000).
18. Bhanu Pant, R. C. Agarwala, V.Agarwala and P.P. Sinha, "A study on Fe<sub>3</sub>Al and TiAl produced by PM route", APT-2000, Bangok, Dec.(2000).
19. R. C. Agarwala, V. Agarwala and A.K.Jena, EMF Cell Set up and thermodynamic investigation of liquid Pb-Bi alloys at 550C and 575C, Z.Metallkd. 915 (2000)
20. .S.B.Sharma, R.C. Agarwala, V.Agarwala and S.Ray, " Wear and friction Behaviour of Ni-P-ZrO<sub>2</sub> -Al<sub>2</sub>O<sub>3</sub> composite Electroless coating". International Conference on Mechanical Engineering, ICME 2001, Dec. 26-28, BUET, Dhaka. (2001).
21. S. B. Sharma, **R. C. Agarwala**, V. Agarwala and S. Ray, "Dry Sliding Wear and Friction Behaviour of Ni-P-Al<sub>2</sub>O<sub>3</sub>-ZrO<sub>2</sub> Composite Electroless Coatings on Aluminium", International conference proceedings, 1-3 Feb, "ICAMMP – 2002", IIT, Kharagpur (2002).
22. **R.C. Agarwala**, V. Agarwala, S. Ray, D. Deep and P. Johri "A Study On The Electroless Ni-P-Al<sub>2</sub>O<sub>3</sub> Composite On Steel Substrate", Under review, BHM(2001)
23. S. B. Sharma, **R.C.Agarwala** V.Agarwala and K. G. Satyanarayana "Development Of Electroless Composite Coatings By Using In- Situ Co- Precipitation Followed By Co-Deposition Process," submitted to Met Trem A.(2003).
24. S. B. Sharma, **R.C.Agarwala** and V.Agarwala, "Characterization of Carbon Fabric Coated with Ni-P and Ni-P-M<sub>c</sub>C<sub>oy</sub> by Electroless Technique", Journal of Material Sciencep5247, vol 37 (2002).
25. S. B. Sharma, **R. C. Agarwala**, V. Agarwala and S. Ray, "Dry Sliding Wear and Friction Behaviour of Ni-P-Al<sub>2</sub>O<sub>3</sub>-ZrO<sub>2</sub> Composite Electroless Coatings on Aluminium", accepted, Journal of Materials and Manufacturing processes, Marcel Dekkar publication (2002)
26. N.N.Tripathi, P.Kumar, V.Agarwala and R.C.Agarwala, Development and validation of sliding wear model and its application for coated sample. Under review, SRIPTA Metallrgia(2001).
27. S.B.Sharma, R.C.Agarwala and V.Agarwala, "A study on synthesis and empirical model development of EL Ni-P based composite coatings", accepted for the presentation in the International conference, Surface Engineering for Competitive Advantages (SECA-2002) Newcastle upon Tyne, UK, 2-5 sept.(2002)
28. S.B.Sharma, R.C.Agarwala and V.Agarwala, "Application of Ni-P-ZrO<sub>2</sub> – Al<sub>2</sub> O<sub>3</sub> –Al<sub>3</sub>Zr composite EL coatings and their characteristics,accepted for the presentation in the

- International conference”, Surface Engineering for Competitive Advantages (SECA-2002) Newcastle upon Tyne, UK, 2-5 sept.(2002)
29. Noori Bhanu, V.Agarwala and R.C.Agarwala, “Optimization of Coating Techniques” A data base soft ware , Accepted for demonstration in the International Conference, Surface Engineering for Competitive advantages (SECA – 2002) , to be held at Newcastle upon Tyne, UK, during 2-5 Sept. (2002) .
  30. Sunil Sharma, R.C.Agarwala and V.Agarwala, "Wear and friction behaviour of EL Ni-P-ZrO<sub>2</sub> -Al<sub>2</sub>O<sub>3</sub> coatings on steel substrates", under review for Met Trans A Jan(2003).
  31. R.C.Agarwala, V.Agarwala and S.B.Sharma “Electroless Ni-P based coating technology: A retrospect”, A review paper communicated to Kluwer academic Publishers( march 2003)
  32. Bhanu Pant, R.C. Agarwala, Vijaya Agarwala & P.P. Sinha, “Non – isothermal DSC Reaction Kinetics on Ti48Al System to Obtain Activation Energy & n by Johnson-Mehl-Avrami Equation” Communicated to Metall Kunde, (2003).
  33. Sunil Sharma, R.C.Agarwala and V.Agarwala," , A study on Synthesis and Emperical Model Development of Electroless Ni-P Based Composite Coatings.” communicated (2003)
  34. S.B. Sharma, Agarwala et. al. “Tribological studies of Ni-P-M<sub>x</sub> O<sub>4</sub> Electroless Coatings on Steel Substrate” communicated.

### National level

1. **R.C. Agarwala** ,Vijaya C. Das and N.K. Garg, “ A study on Resistivity of Manganese Ore – Coke mixture at High Temperature”, Awarded for Tech. Essay/ Article and presented in 11<sup>th</sup> National Metallurgists’ Day,IIT, kanpur (1973).
2. Rajneesh Garg, S. Mohan, V. Agarwala and **R.C. Agarwala** “A study on the correlation between buld wear and roughness of rheocast leaded aluminium alloy” Metallurgica, J. Met Engg. Society, Vol. 7,9-11,(1993).
3. Rajneesh Garg, S. Mohan, V. Agarwala and **R.C. Agarwala** “Wear characteristics of rheocast leaded aluminium alloy”, Technical report - CSIR 21-41, (1993).
4. Rajneesh Garg, S. Mohan, V. Agarwala and **R.C. Agarwala** “A study of the correlation between the bulk wear and roughness of rheocast leaded aluminium alloy”, Technical Report- CSIR 42-62, (1993).
5. Sandeep Dutta, S. Mohan, V. Agarwala and **R.C. Agarwala** “Effect of heat treatment on the mechanical properties of MS wires embedded Al Alloy”, Technical report - CSIR 17-31 (1994).
6. **R.C. Agarwala**, V. Agarwala and V. Singhal, “Stress corrosion study of electroless silver plated Al-3.8% wt Mg alloy”, National seminar on Surface Engineering , The Institute of Engineers, Jaipur , 5-6 Sept.(1997).
7. V. Agarwala and **R.C. Agarwala**, " MMC for space applications" Internationes Conference ICWC, Expanding frontiers of Science and Tech, IWSA, Bombay Oct. (1998).

8. **V. Agarwala, R.C. Agarwala** and K.G. Satyanarayana, "Tensile properties of MS wires reinforced aluminium alloy castings at elevated temperatures", 52<sup>nd</sup> Annual Technical Meeting, Indian Inst. Of Metals, IISc Bangalore, 16-17 Nov. (1998).
9. **V. Agarwala, K. G. Satyanarayana, R.C . Agarwala** and S. Mohan, " Effect of heat treatment on the wear resistance of MS wires reinforced aluminium alloy", Platinum Jubilee Celebrations PJC-BHUMET, International Conference on Metallurgical Technologies, IT BHU, 9-12 dec. (1998).
10. **R. C. Agarwala, V. Agarwala** and S. B. Sharma, "Engineering Surface Preparation by Electroless Nickel based Coating Technology: A Promising Area in Industrial Applications", Proc. Institute Industry Interaction Meet on Metal Matrix Composites, Oct 9, 1999, Metallurgical and Materials Engineering Dept., University of Roorkee, (now Indian Institute of Technology), Roorkee, Eds. Agarwala et al., pp. 32-40 (1999).
11. **R. C. Agarwala, V. Agarwala** and **S. B. Sharma**. " A Study on Electroless Ni-P based Composite Coatings by Co-Deposition of Hard Particles", Proc. National Seminar, Advances in Materials and Processing, Nov. 9-10, 2001, Metallurgical and Materials Engineering Dept., IIT, Roorkee, Eds. S. Ray et al., pp. 172-179 (2001).
12. **R.C. Agarwala**, Delivered lectures on Electroless coatings in a short term training course for Srilankans on 'Advanced Materials Engineering' at MMED, IITR., 24 Sep t- 23Nov., (2001).
13. **S. B. Sharma, R. C. Agarwala, V. Agarwala** and S. Ray, "Dry Sliding Wear and Friction Behaviour of Ni-P-ZrO<sub>2</sub>-Al<sub>2</sub>O<sub>3</sub> Composite Electroless Coatings on Aluminium", Proc. International Conference on Advances in Materials and Materials Processing (ICAMMP-2002), Feb. 1-3, 2002, IIT, Kharagpur, India, Eds. N. Chakraborti and U. K. Chatterjee, pp. 326-330 (2002).
14. **R.C. Agarwala**, Delivered lectures on Radiography in the short term course on 'Non destructive testing' at ONGC, Dehradun, May 13-18, (2002).
15. **R.C. Agarwala**, presented Invited Paper on "EL alloy and composite coating An over view", International conference, Nonferrous-2002, at NFTDC, Hyderabad held during 28-29 June, (2002).
16. **Bhanu Pant, R.C. Agarwala, Vijaya Agarwala, P.P. Sinha** and George Thomas, "Gamma Titanium Aluminides for Space Applications", Presented at Science & Technology of Advanced Engineering Materials (STAEM -2003) at Indian Institute of Metals, Thiruvananthapuram, 20-21 Feb. (2003).
17. **S. B. Sharma, R.C. Agarwala** and **V. Agarwala**, "Synthesis of Electroless Composite Coating by Use of Co-Precipitation Reaction", Accepted for presentation and publication at

National Conference on World Class manufacturing at Amurita Institute of Technology, Coimbatore, India, May, (2003).

18. **R.C.Agarwala** and Vijaya Agarwala, **Review paper** on “Synthesis and characterisation of Electroless alloy and composite coatings”, Special Issue on ‘Frontiers in Materials Science”, Academic Proceedings in Engg. Sci., Sadhna Indian Academy of Science, vol.29, part1&2 , (June. 2003).
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