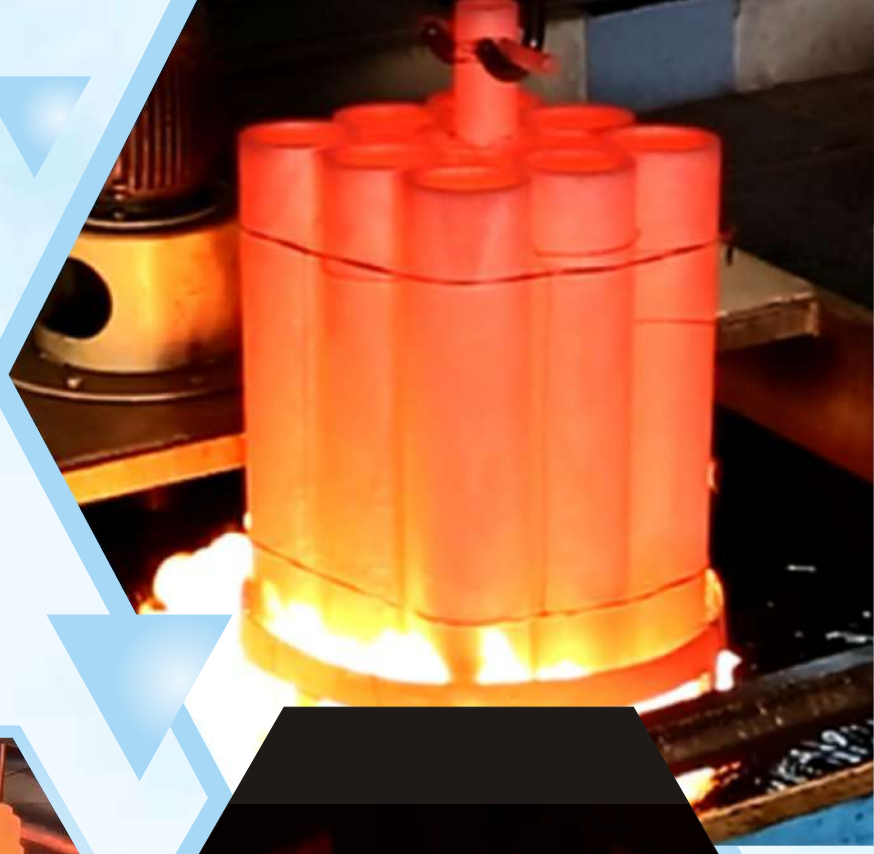
ASM INTERNATIONAL Pune Chapter

M&MT 2024

Materials & Manufacturing Technology

Technical Souvenir



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ASM International Pune Chapter
is organising a two days International Conference & Exhibition on

Materials & Manufacturing Technology 2024
with a focus on Heat Treatment & Surface Modification

Dates
4th - 5th December 2024

Venue | **Hotel Pride, Ganeshkhind Road, Shivajinagar, Pune-411004.**

For the conference M & MT 2024 Email : mmt24.asmpune@gmail.com
www.asmpunechapter.org

ASM INTERNATIONAL PUNE CHAPTER

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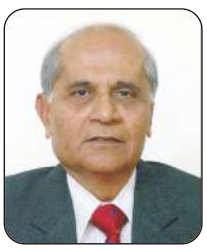

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ASM INTERNATIONAL
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MESSAGE

Dear Members and Friends of ASM India,

It is with immense pleasure and a profound sense of community that we welcome you to the ASM India Event in Pune. This gathering is much more than just a meeting; it is a celebration of the vibrant and thriving materials community that we are privileged to be a part of.

This event serves as a bridge, bringing together materials professionals, researchers, educators, and enthusiasts from across the country. It is an opportunity to connect, share knowledge, and foster collaborations that strengthen the bonds within our community.

Our materials community is rich in its diversity of backgrounds, experiences, and perspectives. This event is a testament to that diversity, showcasing the vast talent and expertise that collectively drive the field of materials science and engineering forward. Whether you are an industry veteran, an academic researcher, or a student beginning your journey, you are an integral part of this tapestry.

We extend our heartfelt gratitude to everyone who contributed to making this event possible. This includes our dedicated organizing team, our members, and the ASM India leadership for their unwavering support and vision.

As you participate in the sessions, engage with peers, and explore opportunities for collaboration, we encourage you to immerse yourself in the vibrant spirit of this community. Let this event inspire you, connect you, and energize your contributions to the field of materials science and engineering.

On behalf of ASM India, we express our deepest appreciation for your continued support and engagement. Together, we will continue to advance the field, making meaningful contributions to society and industry.

Welcome, and let us make this event a memorable milestone in our journey forward.

Warmest Regards,

Dr. Navin Manjooran

Ph.D., MBA, FASM, FACerS, FIIM, FIMMM

President and Chair of the Board of Trustees, ASM International

Chairman, Solve

MESSAGE

Dear Team ASM Pune,

I am delighted to extend my heartfelt congratulations on the successful organization of the upcoming Materials & Manufacturing Technology 2024 conference and exhibition. This ambitious event, focusing on cutting-edge developments in heat treatment and surface modification, is a testament to your hard work, dedication, and passion for advancing our field and the visibility of ASM International.

Bringing together renowned speakers from industry and academia from around the globe, as well as hosting a concurrent exhibition, is no small feat. The effort each of you has invested in ensuring the seamless execution of this prestigious event demonstrates exemplary teamwork and commitment to excellence.

My special appreciation and thanks to those involved in securing the remarkable lineup of speakers, organizing the logistics, coordinating with sponsors, and managing every intricate detail. I am confident that the conference promises to be an invaluable platform for knowledge-sharing, networking, and fostering innovation in the materials and manufacturing industry.

Let us take pride in this achievement and use it as a momentum to continue raising the bar. Thank you for your dedication to the field of materials science in general and ASM in particular, and congratulations once again on making M&MT 2024 a hallmark of success.

Best regards,
Pradeep Goyal
President, 2023-24
ASM International

MESSAGE

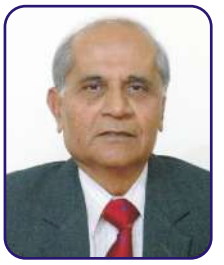
I am delighted that the ASM International, Pune Chapter is organizing an International Conference on Materials & Manufacturing Technology (M&MT) 2024 with a focus on Heat Treatment and Surface Modification on 4th & 5th December 2024 at Hotel Pride, Shivaji Nagar, Pune. The idea of organizing the International Conference on Heat Treatment and Surface Modification was finalized during discussion of the Executive Council of ASM International, Pune Chapter with me seeing the importance of Surface Treatment Technology and their role in huge financial savings globally by combating the losses due to corrosion and wear. In last 10 years, enormous research has gone into the area Heat Treatment Processes and Surface Treatment which has given outstanding results in material saving and in increasing the efficiency of JET Engines, Automotive Components, Components for Oil & Gas Industries, Mining & Material Handling and so many Defence Applications.

The participation has come from both Industry experts and Academic scholars working in the field. The conference will come out with solutions to so many teething problems being faced by Industry across the world through the deliberations and discussions during various technical sessions.

I convey my best wishes to the organising team for the success of the conference in terms of meeting the envisaged objectives.

Dr. Raj Kumar Prasad Singh
Sr Director – Kalyani Centre for
Technology & Innovation
Bharat Forge Limited
Chairman – M&MT 2024

MESSAGE



I am pleased to note that Pune Chapter of ASM International has organized Technical Conference and Exhibition, "Materials and Manufacturing Technology 2024 with a focus on Heat Treatment & Surface Modification on 4th& 5th December 2024.

Being associated with Pune Chapter for the last 30 years in various capacities, I have been a witness to the transformation of a small dormant Chapter to one of the major and vibrant chapters in India. It is striving to fulfill the vision and mission of its parent body of Dissemination of Materials Knowledge to Technical fraternity. This is achieved by Technical Presentations, Educational Courses, Newsletters, Student outreach programs and National and International Conferences. Its iconic series of M & MT, Technical Conference & Exhibition facilities interaction between National and International speakers, delegates and exhibitors on latest advances of Technologies.

This year's event is focused on Heat Treatment & Surface Modification which is of great interest of the Materials fraternity. I am sure that intense discussions over the two days would prove beneficial to all the participants.
I wish a great success to the Conference&Exhibition!

Dr. P. G. Renavikar, FASM
Past Chairman
Pune Chapter and INC

MESSAGE

Dear All,
ASM Pune has been playing a key role in knowledge dissemination for the last 32 years through training programmes,seminars and conferences; keeping in tune with new technological developments in Materials & Processes.

I am happy to be associated with this conference right from its conceptualization to now, shaping the mobilization of all the resources to make this event successful year on year. This conference is a testimony of the vision that is created through the strength of volunteering and passion about the domain.

For me, this journey is full of excitement while reconnecting with industry colleagues, Heat Treatment suppliers, academia and working with young ASM members to whom this legacy of volunteering is to be passed onto.

I take this opportunity to thank all stakeholders who have participated in the conference & assure them that they will immensely benefit from this event.

With Best Wishes,
Bhimsen R Galgali
Past Chair, ASM Pune Chapter
Vice Chair, ASM India National Council

MESSAGE

Dear Friends & Fellow Material Professionals,

It is a great feeling to regroup for "M&MT" after a long gap of 7 years. This is our 5th conference in the M&MT series that began way back in 2010. The conference has a focus on Heat Treatment and Surface Modification. We look to bring the Latest & Industry relevant technologies to this event.

The enthusiasm of our organizing committee has been very high. Need to mention some of the silent members such as Mr. Hemant Zaveri, Mr. L D Deshpande, Mr. Y S Gowaikar, Dr. Kadam and many more here.

We have benefitted greatly from the support and advise of our senior members especially Dr. R K Singh, Shri. B R Galgali, Shri. R T Kulkarni, Dr. Sudarshan.

We have been generously supported by our esteemed Sponsors & Exhibitors. Their support goes a long way towards the success of our event.

The measure of any such event is the quality and relevance of the papers. I am sure there will be many takeaways for all the delegates from our conference. Our technical committee led by FASM Mr. Udayan Pathak has put in a lot of effort in selecting the relevant topics and papers. Many of our authors have travelled great distances and have put in a lot of effort to reach out to you and share their presentations. I am sure this will be of great benefit to all and everyone would appreciate their efforts.

Pune Chapter is one of the most vibrant chapters globally & our efforts have been acknowledged by ASM International through numerous awards conferred upon us year after year for the past 15 years! Our Women's Day Program led by Ruta Barve was highly appreciated globally and was printed in advance material and processes.

We Mentor and Support 6 Material Advantage (Students) Chapters. Our Vice Chairman Shri D G Chivate is very passionate about the students activities and had put in a lot of effort towards development of these chapters.

Thanks to the Vision of our Founding Chairman Padma Vibhushan Shri. B N Kalyani, a lot of what we enjoy today, is due to his leadership 30 years ago and his mentorship down the years.

The Indian flag fly's high globally. We have the largest membership after the USA. I have nostalgic memories of my interactions with Late Dr. H M Mehta who brought ASM to India and our Dear friend Late Shri Prem Aurora. Their contribution to the growth of ASM in India is invaluable.

We are extremely proud that FASM Shri. Pradeep Goyal has been the First ASM President from India. We take a bow to his achievements and are grateful for his patronage, support and presence and guidance always.

Looking forward to seeing you all at M & MT.

Rahul Gupta
Chairman, ASM International
Pune Chapter

MESSAGE

Empowering Women in Metallurgy: A Vision for Progress

As the leader of the Women Metallurgical Engineers' Wing of ASM International Pune Chapter, it gives me immense pride to share my vision withall professionals and researchers through the souvenir of this MNMT '24 Conference. This platform not only celebrates the advances in our field but also highlights the growing contributions of women in shaping the future of metallurgy and materials science.

The metallurgical industry has long been perceived as male-dominated, but the tides are shifting. Women are making remarkable strides as engineers, researchers, and leaders, breaking barriers and bringing fresh perspectives to critical challenges in metallurgy. From advancements in sustainable materials to innovation in manufacturing processes, the inclusion of diverse minds is driving a transformation in our field.

At the Women Metallurgical Engineers' Wing, our mission is to create an ecosystem where women in metallurgy can thrive. We aim to foster mentorship, encourage skill development, and provide platforms for knowledge sharing. By empowering women, we empower the entire community, enhancing collaboration and innovation across the sector.

This conference is a testament to the collective commitment of metallurgists to push boundaries, embrace diversity, and address the pressing needs of our time. Let us continue to inspire and support each other, forging a path toward a future where talent and merit transcend gender.

I extend my heartfelt gratitude to the organizers for their vision and dedication, and I encourage every participant to engage actively, network, and exchange ideas. Together, let us build a stronger, more inclusive metallurgical community.

With warm regards and best wishes for a successful conference

Ms Ruta Barve.
Leader, Women Metallurgical Engineers' Wing
& Secretary, ASM international Pune Chapter

ABSTRACTS

Prof. Dr.-Ing. Omkar Nath Mohanty
Director, Technology & Academic Initiative,
RSB Metaltech., RSB Group, Pune.

Academic & Professional -

Is a B.Tech. and M.Tech. in Metallurgical Engg. from IIT Kharagpur; a Ph.D (Dr.-Ing.) in Materials Engg. from the University of Karlsruhe, Germany and did a course in Business Administration from CEDEP (a part of INSEAD), France.
Served as a Professor at IIT Kharagpur; Director-level Scientist at CSIR- National Metallurgical Lab. (NML) Jamshedpur; Director (Research & Development) at Tata Steel; Tata Research Professor at IIT Kharagpur, and Vice-Chancellor, Biju Patnaik University of Technology, Odisha, before taking up the current position in 2010. Inducted as Adjunct Professor, IIT Bhubaneswar and a Honorary Scientist at CSIR-Inst. of Minerals & Materials Technology (IMMT), Bhubaneswar, Govt. of India.
Was a Consultant, United Nations Industrial Dev. Organization (UNIDO) at Harare & Vienna.; the Chairman of the UK-India Committee on Materials Sciences; the Indian-side Coordinator of the Indo-US Project on, Special Steels; and a Member, International Consortium on, Ultra Light Steel Auto Body (ULSAB) & ULSAB-AVC Programmes of the International Iron & Steel Institute (IISI). Had a major role in coordinating the setting up of the first Steel Technology Centre (STC) of the Govt. of India (Min. of Steel) at IIT Kharagpur (2005)
Served as the Chairman, Accreditation Evaluation Committee (AEC) of the Engineering & Technology Group of the National Board of Accreditation (NBA), Govt. of India. Former Member, Board of Governors, IIT Kharagpur; IIT Bhubaneswar.
Supervised 13 Ph.D (doctoral) dissertations and 15 M.Tech. dissertations in the area of Metallurgical & Materials Engineering. Holds 17 Patents.
Published over 130 original research papers, written chapters in several international books, holds 17 patents

Major Recognition -

- Fellow , National Academy of Sciences, India.
- National Metallurgist's Day (NMD) Award of the Min. of Steel, Govt. of India
- Tata Steel (R&D) was awarded the Best Industrial R&D in India under his stewardship for developing high strength auto steel (IF-HS) by DSIR, Govt. of India
- Materials Research Society of India (MRSI) Award
- Elected a Member of the Asia-Pacific Academy of Materials
- Visvesvaraya Award of Inst. of Engineers, India
- Lifetime Achievement Award, Inst. of Mineral Engrs. India, Bhubaneswar Chapter

Shot Peening of Automotive Gears: measurement & optimization of residual stress

Omkar Nath Mohanty
RSB Transmission (I) Ltd

ABSTRACT

Gears will continue as a critical machine element for transmitting power in automotive due to their high degree of reliability and compactness. Pitting failure, one of the main damage mechanisms in the gears which is the surface fatigue failure occurs due to the repetition of Hertz contact stress between the meshing teeth. Since nearly seven decades , it was known that introducing compressive residual stress would mitigate the pitting damage in gears. Which is why, while the surface treatments such as carburizing, nitriding, induction hardening and so on, impart the needed wear resistance to the gears, they would fall short on the quality and intensity of compressive residual stress needed to counter pitting .crack initiation and propagation in gears

The presentation deals with gears made from carburizing grades of steel (20 MnCr5, 27 MnCr5, etc.) that is carbonitrided and is then shot peenedin a commercial shot peening unit in which the conventional Almen strips are used for regulating the kinetic energy of the shots, and hence the process,in the desired manner.

The residual stress was measured, asper the requirement of the customer, at three different locations(tooth flank, root radius and root) of the gear. Further, the stress values were required at each location, for 4 depths. The residual stress was measured using a portable X-ray residual stress measuring device, making use of the sin2 Ψ technique.

The paper deals with some details of the probable errors in stress measurement by XRD,and their corrective techniques. The distribution of stress with depth, and its simple interpretation according to the Herztian theory of metallic contact, would also be invoked and correlated with the pitting fatigue behaviour and its mitigation.
Some discussion on the optimisation of residual stress as a function of the percentage of shot-peened area covered, would be included. Elements of new developments in the XRD technique, such as the area-detector based Cos amethod (as opposed to the line detector-based sin2 Ψ process) will be pointed out.

The paper would also attempt to discuss possible methods of residual stress determination by non-XRD techniques such as Barkhausen Noiseand their adequacy, for the ease of handling on the shop floor.

At the end, the paper would argue that it may be worthwhile to examine application of other variants of shot peening, such as wet shot peening (WSP) process and shot peening as a pre-processing technique, for special advantages based on newer evidences. Similarly, the use of laser shot peening, although in existence for some time, would also be re-examined in the context of new generation gears in automotive.

Cryogenic Treatment of Die Steel

Dr. Rajkumar Singh, Panchakshari Hiremath, Azhar Thanedar, Vivek Chobhe
Kalyani Centre for Technology and Innovation,
Bharat Forge Ltd, Pune-411 036, India.

ABSTRACT

The effect of deep cryogenic treatment (DCT) on the mechanical and tribological properties of H13 die steel used for hot extrusion punch is studied in the present work. Deep cryogenic treatment (DCT) is a heat treatment of tool steels that has gained attention recently. Normally it is combined with the traditional heat treatment, where after quenching, the material is exposed to cryogenic temperature -196 °C immersion into liquid nitrogen followed by double tempering at 148 °C for 2 hrs. DCT transforms RA (retained austenite) into martensite, removes internal stresses, and increases the secondary carbide density. In addition, it helps in the formation of smaller and more uniform martensite laths distributed in the microstructure. DCT improves the wear and fatigue resistance while maintaining hardness.The investigation includes wear analysis, metallographic analysis, hardness depth profiling, and mechanical testing. Results indicate the enhancing effect of DCT and a significant improvement in the working life of the extrusion punch.

Keywords: Deep cryogenic treatment, wear resistance, microstructure, die steel

Promises in the Kaleidoscope of Coatings and Surfaces

Dr Tirumalai Sudarshan,
Materials Modification Inc, Fairfax, Va 22031

T.S. SUDARSHAN (Suds) is currently the President and CEO of Materials Modification, Inc. He received his B.Tech. in Metallurgy from the Indian Institute of Technology in Madras, India, and his M.S. and Ph.D. in Materials Engineering Science from Virginia Tech. He worked with Ashok Leyland in the Truck and Bus division as a Senior Metallurgist and later as the Director of R and D at Synergistic Technologies Richmond, Va. For the past 38years he has been responsible for the management and technical development of innovative materials, processes, and techniques and the development of new technologies related to surface engineering and nanotechnology. He has been active in various committees throughout his career and is currently the Chair of the ASM-IIM lectureship committee. He also chaired the Surface Engineering Critical Technology sector and has been a member of IMR, JMEP, AMP journals and numerous Awards committees and has also served as a Trustee of ASM International.

Dr. Sudarshan has been the recipient of numerous awards and honors, including the Design News Award and R&D 100 for the microwave plasma technique"Nanogen" and for the Plasma Pressure Compaction technique and the Outstanding Young Manufacturing Engineer award from SME. He has served on several selection committees for decades of the National Science Foundation, National Institutes of Health, U.S. Army, Michigan Economic Development Council, Department of Energy, National Research Council, Ohio Third Frontier and ASM International–The Materials Information Society. He has also served on the technical advisory boards of various materials based companies over the last two decades. Dr. Sudarshan is the editor of two journals Materials and Manufacturing Processes for 36 years and Surface Engineering for more than 27 years and Materials Technology for 4 years. He is a Fellow of ASM International, Fellow of International Federation for Heat Treatment and Surface Engineering and Fellow of Institute of Mining, Metals and Materials, UK and Distinguished Alumnus of IITM and was a member of the National Materials Advisory Boardwhere he served on numerous NRC committees. He is the coauthor of 195 publications and coeditor of 36 books including 30 books on surface modification technologies and holder of over 38 patents, developed 18 products and has given over 60 plenary and keynote lectures throughout the world and taught numerous courses in several countries.

Promises in the Kaleidoscope of Coatings and Surfaces

Dr Tirumalai Sudarshan,
Materials Modification Inc, Fairfax, VA 22031

ABSTRACT

The field of coatings has grown by leaps and bounds with the advancement of processing equipment, analytics and innovative chemistry to introduce solutions for a never ending set of requirements. Unlike in the past, university and Industries are working in tandem to bring to market many solutions that are affordable and with reduced toxicity and ease of application. Global expansion of manufacturing has improved the ability to arrive at solutions that are easily transferable with acceptable performance or durability at a cost that is acceptable to the end user especially in engineering applications. While some of the approaches have established the science by drawing upon nature, the technology and development are evolving and innovating at a galloping speed. Endless possibilities are now feasible leading to the need for a whole new generation of materials scientists that can harness the value of machine learning and artificial intelligence in the years ahead.

Understanding CQI 9
Heat Treatment System Assessment

Abstract for Paper to be presented in
ASM – Conference in Pune on 4th& 5th DEC 2024

Deepak Kulkarni

ABSTRACT

- Heat Treatment is a Special Process & hence (AIAG)Automotive Industry Action Group a Globally recognized organization has formulated a common standard for the worldwide Automotive OEM's ,Suppliers unite together to address & resolve issues affecting worldwide automotive supply chain.
- CQI – Continuous Quality Improvement and other related CQI guidelines are developed by AIAG for the reference to be followed for conducting internal audits& External Audits for Automobile OEM & OEM's Suppliers.
- CQI 9 is a Guideline for Heat Treat System Assessment to be followed by all automotive OEM & Their Suppliers throughout the entire supply Chains.
- As per IATF 16949:2016, Annex. B: Supplemental Automotive, CQI-9 and other related CQI guideline reference to be followed for conducting internal audits & Heat Treatment Suppliers audits.
- The purpose of the guideline is to provide an understanding of the CQI-9 Edition 4 standard, & is aimed at both suppliers & end users in the Heat –Treatment industry.
- The Goal of Releasing CQI 9 Guideline is to
- Reduce cost
- Reduce complexity through collaboration
- Improve product quality
- Improve health, safety and environment
- Optimize speed to market, throughout supply chain.
- CQI-9 was first published by AIAG (Automotive Industry Action Group) in 2006 to serve as a uniform Heat -Treat management audit system that provides:
- Continual improvement,
- Prevent defects,
- Reduce variation and waste in the supply chain.
- AIAG is Continuously Upgrading this CQI 9 Guidelines based on users feedback to the Formulating Committee of CQI 9 & the Problems faced during Internal & External Assessments.
- Driven by a number of very public recalls in the automotive industry over the past few years, there is definitely a heightened view on quality in the supply of components in the Automotive Industry.

- Purpose of HTSA – Heat Treatment System Assessment
- To assess an organization's ability to meet :
- CQI-9 requirements,
- Customer requirements,
- Regulatory requirements
- Organization's own requirements.
- It can be also used between an organization & its suppliers.

- HTSA Goal
- Coupled with internationally recognized QMS applicable
- Customer specific requirements
- Defines fundamental requirements.
- Provide common approach to Heat treat management System for automotive production & Supplier organizations.
- Develop Heat treat management system to provide :
- Continual improvement
- Emphasize defect prevention
- Reduction of variation & waste in supply chain.

Faculty :
Deepak Kulkarni –

- Metallurgical Engineering Graduate from COEP – College of Engineering Pune – 1984 batch
- 41years Experience in Heat Treatment with the exposures to Vacuum Heat Treating , Vacuum carburizing , Atmosphere Heat Treatment , Metallurgical Laboratory , Failure Analysis & steel Mill development.
- Worked in Organization Like BOSCH INDIA
- Presently Freelanced Metallurgical & Heat Treatment Consultant / Trainer / Assessor for All CQI
- Special Work Area – CQI 9/11/12/15/27/29/30 - Assessment & training
- Presently a freelance Heat Treatment and CQI-9 consultant,
  Conducting training and assessment on this topic.

Heat Treat
Special Process Heat Treat System Assessment

By doing a heat treat system assessment, a heat treat supplier will be able to identify areas within their heat treat processes that need improvement based on industry best practices. Benefits of aligning your processes to the CQI-9 Special Process Heat Treat Assessment may include a reduction of campaigns, spills, recalls and warranty claims related to heat treated components. The management system will emphasize continual improvement, defect prevention and the reduction of variation and waste in the supply chain.

The first edition of CQI-9 was released in March 2006 and quickly became the global "standard" for assessing an organizations heat treat processes. Over the years the Heat Treat work group has received questions asking for clarification and suggestions on how they could improve the assessment. The 2nd edition was published in 2007 and provided additional clarification considering global users, and a new process table was added for Annealing, Normalizing and Stress Relieving. The 3rd edition was published in October 2011 and included three new process tables, changes in frequency for SAT and Instrument Calibration, formatting and clarification among other items too numerous to list.

Current Publication:
Heat Treat Systems Assessment (CQI-9) , 3rd edition

Nitriding process optimization for high-speed diesel fuel injector nozzle

Madhuri Thombre[α], Prasanth Karakavalasa[b], Rajeev Arora[c], Cummins India

ABSTRACT

The fuel injector nozzle is a vital component in a diesel engine which strongly influences engine performance and emission control. Being exposed to extreme conditions such as high temperatures (~850°C) and pressures up to 3,000 bar during operation, it requires high temperature strength, wear resistance and fatigue strength. These are achievable through careful material selection and precise heat treatment.

Due to its complex geometry, which has a 3 mm blind hole and large L/D (>8), heat treating it possesses several challenges during design & development. Hence it needs precise process controls to ensure optimal output. The surface properties of the nozzle were enhanced through a zero-flow nitriding process. While zero-flow technology has been successfully applied to various fuel injectors for automotive applications, its use in high-pressure high speed diesel engine systems remains limited.

Key input process variables were studied during this nozzle development, including but not limited to, the cleanliness of parts prior to heat treatment, raw material chemistry and critical nitriding parameters like potential (Kn), time and temperature. Optimizing these parameters significantly improved the nozzle properties, leading to enhanced performance. Microstructure, effective case depth and phase analysis were assessed using optical microscopy, microhardness tester and XRD analysis while fatigue performance was checked using a hydrodynamic pressure fatigue test

α – Primary presenter
(contact: madhuri.thombre@cummins.com)
b – Supporting presenter
c - Participating team member

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Hilling 33
4702 Wallern an der Trattnach
Austria
martin.strutzenberger@rubig.com

Personal data -

Date of birth	9.10.1974
Place of birth	Linz
Nationality	Austria

Education -

1989-1993	Technical school for Electrical Engineering
2008-2011	Study: "Automation Engineering"–study alongside job University of Applied Sciences Upper Austria Wels https://www.fh-ooe.at/en/
2012-2018	Study: "Plant Engineering"–study alongside job Passed with Highest Distinction University of Applied Sciences Upper Austria Wels https://www.fh-ooe.at/en/

Bachelor Thesis – University of Applied Science Upper Austria:
"OPC Unified Architecture – the gentle revolution" and "Knowledge-based system to automatically generate heat treatment recipes and predict treatment outcomes"

Master Thesis – University of Applied Science Upper Austria:
"Functional safety and risk analysis – based on a vacuum hardening furnace"

Employment – Career path

1995-1996	Electrical engineer at Rübig Heat Treatment division
1996-2000	Software Engineer at Rübig Industrial Furnace division
2000-2014	Heat of Software Department at Rübig Industrial Furnace division
Since 2014	Sales area Manager at Rübig
since 2023	Director of RUBIG INDIA PRIVATE LIMITED

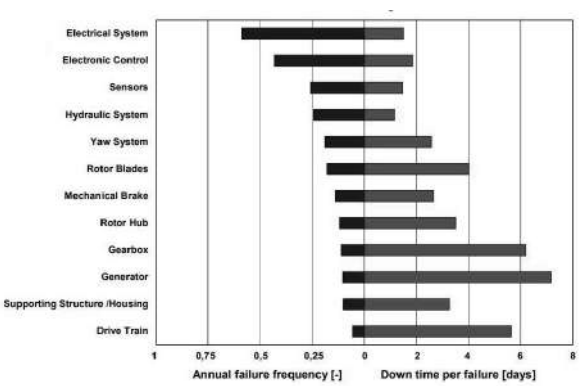
Plasma nitriding and PACVD coating as complementary technology for PVD for wind power gear boxes

T. Mueller1); M. Strutzenberger1);A. Gebeshuber1); Christian Übleis1);
Christoph Lugmair1); D. Heim2); C. Forsich2)
1) Rübig GmbH & Co KG Wels, Austria
2) University of Applied Sciences Wels, Austria

ABSTRACT

Plasma nitriding and PACVD (plasma assisted CVD) are well known surface treatment technologies and are industrially established for decades. Main applications can be found in the fields of automotive, aerospace, tools and dies businesses as well as in new sustainable energy solutions like wind power gear boxes.
For increasing efficiency and life time as well as for reducing numbers of premature failures of the main components (e.g. bearings, gears, ring gears…) of wind turbines (which is directly affecting the maintenance, reliability, and operating costs of the turbine) a variety of thermal and thermochemical (caburizing, nitriding, ,…) and coating technologies (PVD, PACVD) are used. Results are designed stress profiles (thermochemical treatment) to adjust fatigue behaviour and coating like DLC, Cr plating,… to design corrosion and wear properties.
However, besides these requirements a further new challenge is the trend to huge dimensions for high power off shore wind turbines. The increasing importance of size and therefore uniform coating of big complex shaped gears/bearings and the change in used materials versus temperature sensitive steel grades ("zero distortion") pushed new developments to reduce coating temperature and design large area plasma nitriding/PACVD coating processes and combination of these technologies. Many of these parts are limiting the use of standard heat treatment/coating equipment and demand new and tailormade furnaces, coaters and processes.
It will be demonstrated how the combination of high surface engineering requirements on wear, friction, distortion, fatigue with reliable and consistent new heat treatment/coating equipment can be realized.

example of nitrided ring gears in an upscaled and installed plasma assisted nitrider parts of dimensions up to 3.000mm and load weights 30.000kg and bigger can be treated with PN/PACVD technlogy. Based on the used technology fatigue and wear properties can be optimized.



Failure Frequency and downtimes of components
To get a better understanding why lifetime increase by surface modification technology is essential, a comparison of freqency vs. downtime is demonstrated. For components with used medium and high alloyed steel subassemblies nitriding and coating processes can be used as optimization technologies.

Abstract on Metallography practices, machines selections and case studies

Y. S. Gowaikar
Metatech Industries

ABSTRACT

Metallography practices are commonly observed in the industry, research and academia. However for right preparation of specimen, selection of machines, its technology , parameters and consumables selection are most important factors. The presentation focuses on these aspects covering sectioning ,molding , grinding , electro polishing , on site metallography , microscopy , microhardness testers catering to new demands.

Advanced machines / technologies, its automation levels , advantages and limitations of them are also discussed. Few case studies in each category can help developing insights of the process.

All these are focused on heat treatment and coating (Plating) technologies.
Application specific methods developments can be elaborated.

I welcome specific preparation problems so as to give solution to the best of last few decades experience.

Surface Engineered Self-lubricating Coatings For Demanding Forming Operations

Bojan Podgornik
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ABSTRACT

Hot forming, especially hot forming of light alloys, is a very demanding forming application requiring tool material with high strength and toughness and above all good wear resistance at elevated temperatures. Prevailing wear mechanisms in hot forming are abrasive wear and galling, with abrasive wear leading to dimensions mismatch and galling to unstable friction and poor surface quality of the forgings. In order to reduce tool wear and improve forming process different wear resistant coatings are used, often combined with solid lubricants to prevent work material adhesion.

Hard coatings, like chromium nitride (CrN) and diamond-like carbon coatings (DLC), are considered as one of the best candidates for wear protection in many different forming application where adhesive wear and galling dominate. However, low stability of DLC coatings at high temperatures and relatively high coefficient of friction of hard nitride coatings against soft light-weight alloys hinders their applicability, still requiring the use of different lubricants in the most demanding applications. Self-lubricating claddings and coatings with the capability of in-situ forming of sulphur or oxide based lubricious compounds at elevated temperatures, on the other hand, constantly attract interest. This includes different Ag-MoS2containing claddings, metal-doped DLC coatings, as well asV containing PVD coatings.

The aim of the talk is to give overview ofself-lubricating and anti-galling properties of Ni-based claddingsandsome PVD coatings (W-DLC, CrN, CrVN) at elevated temperatures when used in contact against different light-weight alloys and to provide guideline for successful coatings application. Coatings overview includes Ni-based laser cladding with the incorporationof 5 wt% silver and 10 wt% MoS2 as solid lubricant precursors,commercial DLC coatings and CrN coatings doped with V in different concentrations.To simulate hot forming process of forging, wire drawing and extrusion different methods can be used and their suitability will be reviewed. However, testing and comparison of presented coatings were done at different temperatures (RT, 150°C, 300°C and 600°C) and against typical light-weight alloys, including structural steel for forgings, AISI 316L stainless steel, 6xxx series Al alloy and Ti6Al4V Ti alloy. Testing results are evaluated in terms of coefficient of friction vs. load (single and multi-cycle mode), critical load for galling initiation, volume of adhered material and wear track surface analysis, focused on the formation of self-lubricating surface layers and phases depending on the coating type, temperature and work material.

Keywords: self-lubricating coatings, high-temperature forming, galling, wear, light alloys

Advances in Heat Treatment Technology – Addressing Energy and Climate Concerns

Abhijit Banerjee, Ravindra Kale and
Sanjib Kr Mondal (Ipsen Technologies Pvt Ltd)

ABSTRACT

Heat treatment plays a key role in every part of our daily life. Whether it is transportation, aerospace, logistics, agriculture, medicine, infrastructure or food processing, the key components and parts that go into the many products that have become a part of our daily lives invariably have heat treatment as an important process in their manufacturing. It also plays a key role in space exploration with satellite systems, re-entry components and the modern reusable spacecraft, all relying heavily on heat treatment. The global heat-treating market is rather substantial, with a size that reached US$ 104.6 Billion in 2023, expected to hit US$ 143.3 Billion, at a CAGR of 3.4% between 2024-2032. A large part of this money goes into funding research towards upgrading the technological base of this important industry. Many of the advancements focus on energy optimisation and management because heat treatment is a very energy intensive industry. Over and above this the industry faces concerns with environmental impact, sustainable / renewable energy usage, modern concepts of data sharing and predictive, analytical and expert systems that assist in maintenance and process development. We therefore have the modern electrical and fuel (gas) heated systems with ever-lower CO2 and NOx emissions, with the latest being the hydrogen fuel ready "flameless" burners with highest efficiency and energy saving potential. These same burners can now be used in tandem with heating systems that run on renewable energy like solar power – thus allowing heat up with conventional fuel and temperature maintenance with renewable energy. Other than this, a lot of carbon emissions come from the process gases used in heat treatment where today significant work is being done on recycling of exhaust process gases with precise computer controlled enrichment so that nett hydrocarbon usage can be limited. Developments have also come in the field of endogas generators where today it is possible to automatically adjust gas generation based on actual usage in a battery of furnaces. Substantial energy savings and asset utilisation is coming from use of fixtures made from composite materials, which allow more nett weight in the furnace because fixture weight is reduced drastically. The heat treatment industry has also taken large strides in the field of expert systems for process control as well as cloud computing based predictive maintenance systems as well as machine learning and artificial intelligence based system control.

In conclusion, the advancements in heat treatment technology have significantly enhanced the precision, efficiency, and sustainability of metallurgical processes. Innovations such as advanced thermal processing techniques, the integration of AI and machine learning for process optimization, and the development of eco-friendly and energy-efficient methods are transforming the field. These developments not only improve the mechanical properties and longevity of materials but also contribute to reducing environmental impact and operational costs. As research and technology continue to evolve, the future of heat treatment promises even greater improvements in material performance and industrial applications, driving further progress across various sectors.

Industrial Applications of AI/ML in Materials Engineering

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ABSTRACT

Digitization and extensive data creation during the last couple of decades along with ease of data access, cloud infrastructure and democratization of AI toolsets has opened-up significant opportunities for AI applications in Materials Engineering. Traditionally, the scope of materials engineering in an OEM used to be limited to tactical tasks such as quality tests, supplier quality or failure analysis. The ability to influence adjacent functions, including, design, manufacturing, supply chain and quality through the analytics and machine learning applications have opened significant opportunity space for materials engineering teams with AI/ML capabilities. For example, materials or process selection for designer, manufacturing recipe rationalization and supplier quality processes or customer failures can be significantly impacted and improved through this approach. In this presentation, the unique leverage AI methods provide in creating formal approaches and tool-sets as well as in abstracting knowledge from historical decisions, will be discussed. There will be specific examples covering product engineering, manufacturing, and supply-chain decisions. Furthermore, the limitations of these methods will be eluded for a realistic understanding of this area.

Oxidation Coating Life Extension in Gas Turbine Blades

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Ramaiah University of Applied Sciences as
Dean, Research and Innovation, Bangalore

ABSTRACT

Gas turbine blades have oxidation protection coating, on the external surface as well as on the internal cooling holes, to protect the Ni based super alloy hardware from oxidation, during service operation[1-3]. The external coatings are thermally sprayed MCrAlY coatings, having a thickness of 200-300 µms. The internal coatings are diffusion aluminides, measuring between 25-50 ′ ms[1-3]. In both cases, the presence of α′ -NiAl phase in the coating serves as a protective phase in the coating and prevents the base metal from oxidation. Numerous studies have documented the phase evolution of the ′ -NiAl, in both the external and internal aluminide coatings. Being a sacrificial coating meant to protect the base metal from oxidizing during service operation, the coatings are stripped and recoated during every inspection and repair internal. In this study, the extent of degradation of the coatings after several hours of service operation was evaluated. By making use of a LMP (Larson Miller parameter) approach, the coating life extension was enabled, without having to strip and recoat. During repair and refurbishment, the Ni based superalloy blade is subject to various heat treatments, such as pre-weld and post weld heat treatment, post coat diffusion heat treatment, as well as rejuvenation heat treatment given to the base metal to restore the coarsened precipitate (′ ′) microstructure. The ability of the coatings, now with an extended life, to withstand these heat treatments, is studied via a careful mapping of the coating diffusion through the substrate, in order to practically implement the coating life extension.

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Gaseous Ferritic Nitrocarburizing along with Post oxidation process

Abhishek Sharma
General Manager (Operation and Sales)
Unitherm Engineers Limited

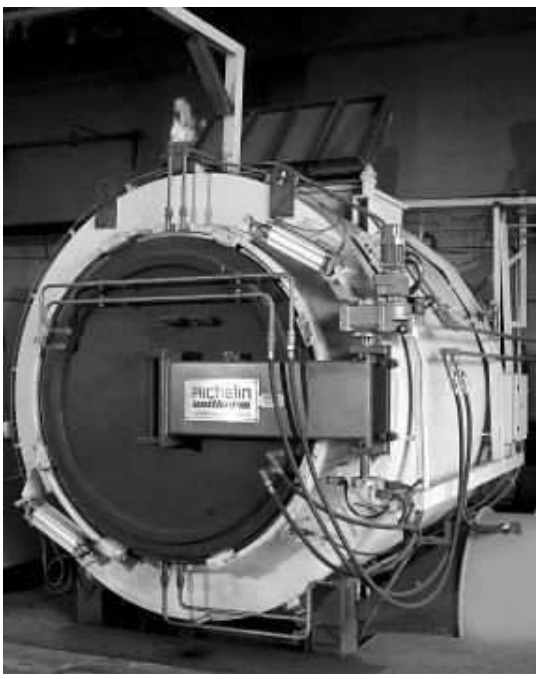
What is FNC , Post oxidation and benefits :

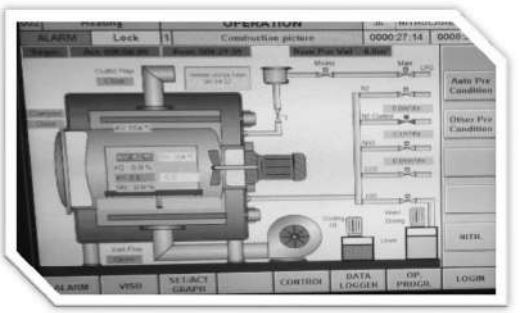
Ferritic nitrocarburizing is a thermochemical process that diffuses nitrogen and carbon into the surface of ferrous materials at temperature completely within the ferrite phase field, in practice below the Fe-N eutectoid temperature. The result of this treatment can be subdivided into a compound layer, consisting predominantly of ε and/or γ' (Fe4N) phases, which is responsible for the good wear resistance and high surface hardness, and in a diffusion zone, where N and C are dissolved interstitially in the ferritic matrix, thus leading to an improvement of fatigue strength when compared to an untreated material.

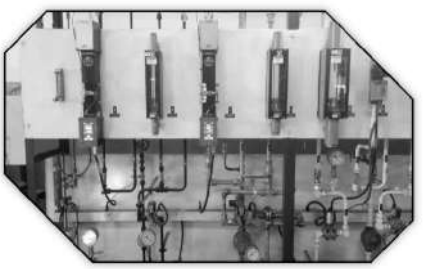
it's possible to generate a duplex hardened layer by producing an oxide film of Fe3O4 on the top of compound layer after nitrocarburizing .The duplex layer presents improved surface properties such as wear resistance, adhesion and self-lubrication. Moreover, the presence of the oxide film leads to a significant improvement of the corrosion resistance of iron-based materials.

It will improve simultaneously mechanical and **tribological properties**, as well as corrosion resistance

Photos of furnaces and control required :







Furnace Type:

- Controlled Atmosphere Furnaces: Retort furnaces with precise control of temperature and gas composition are most common.

•Gas Supply System:

- Mixture of ammonia (NH_3), carbon dioxide (CO_2), nitrogen (N_2), or proprietary blends.
- Gas flow controllers ensure accurate and consistent delivery.

•Oxidation Unit:

- Steam generators or furnaces that operate with water vapor or air at controlled temperatures.

Materials

•Common Steels Treated:

- Low-carbon steels (e.g., C10, C20 grades).
- Low-alloy steels (e.g., 42CrMo4, 34CrNiMo6).
- Tool steels (e.g., H13, D2) for wear applications.

•Material Suitability:

- Best results are achieved with materials containing elements like chromium, molybdenum, or vanadium, as they promote nitride formation.

Process Parameters

•**Gaseous Nitrocarburizing**:

- Temperature: 500–580°C.
- Time: 2–8 hours, depending on desired case depth (typically 10–50 µm for the compound layer).
- Atmosphere: Controlled mix of NH_3 (activator) and CO_2 (carbon carrier), sometimes with N_2 as a diluent.
- Surface Case Depth: Controlled by process duration and gas concentration.

•**Post-Oxidation**:

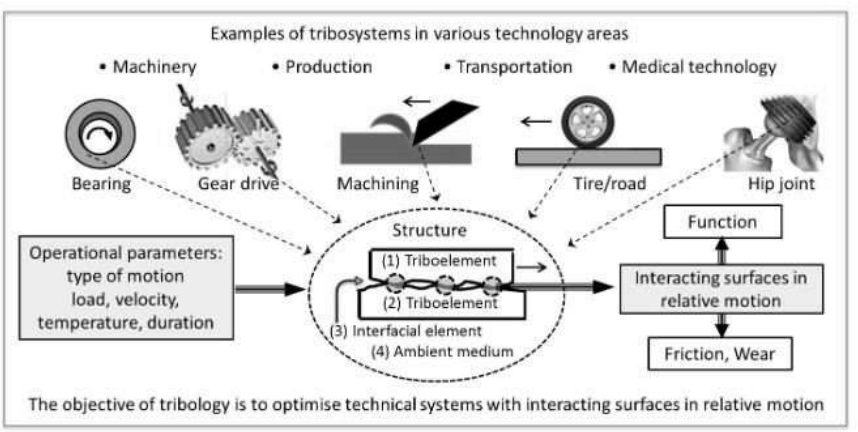
- Temperature: 400–550°C.
- Time: 30 minutes to 2 hours.
- Environment: Steam or humid air.
- Result: Formation of a 1–5 µm thick Fe_3O_4 oxide layer.

Key Benefits:

•Wear Resistance: Increased due to the hardened surface layers.
•Corrosion Resistance: Boosted by the oxide layer formed during post-oxidation.
•Aesthetic Finish: The black oxide finish is visually appealing.
•Environmental Friendliness: Gaseous processes are often cleaner than salt bath nitriding.
•Improvement in tribological properties

Tribological properties

"Tribology is the science compasses the entire field of friction and wear, as well as lubrication and the corresponding interfacial interactions between solids, between solids and liquids, or between solids and gases".

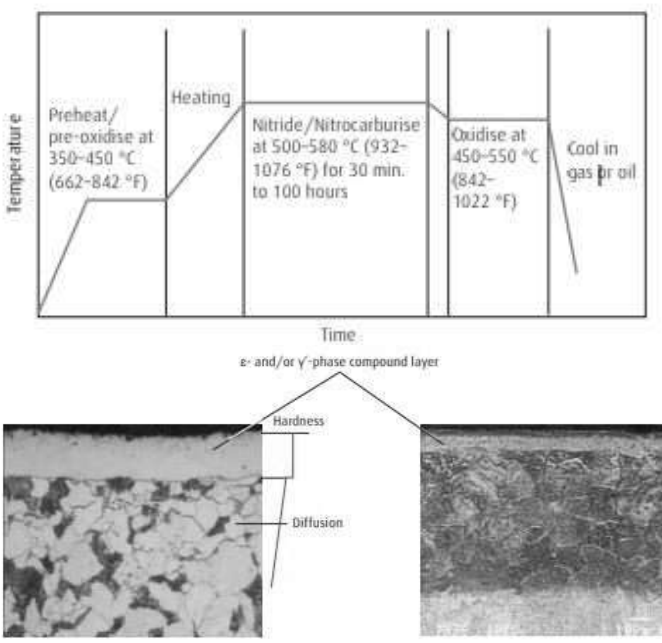


An estimated annual loss between 2 and 7 per cent of the gross national product results from friction and wear in every industrialized country.
The increasing application of tribological information can result in considerable savings in the consumption of energy and material, as well as in production and maintenance costs. Energy and raw material resources can be conserved, environmental damage can be avoided, and occupational safety and protection can be improved.

Photos of FNC over parts : Lustrous grey cement color

Photos of FNC+ Post oxidation over parts : Uniform black color

Process steps and microstructural images :



Plain c steel micro after FNC

5% Cr tool steel microstructure after FNC

Notes

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- Unitherm Engineers Ltd.
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- Stange Elektronik GmbH
- Elca quality Systems & Calibrations Pvt. Ltd
- Quaker Houghton
- MetDerm Treat
- Malvern Pananalytical
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* Residue to be removed just by hot water rinse or alkaline solution.
* Available packings 1 Kg AntiCarb-CS & 1 Ltr Diluent-SCS

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