STARK STATE COLLEGE

GENERAL SYLLABUS

Course Information

Course Name: Advanced Compressor ION Nitriding
Course Number: ARL238

Required Materials

Textbook(s): Advanced Cylinder ION Nitriding Handbook Ariel Corp.
Required Readings: None
Additional Materials: Scientific Calculator, Laptops, Note Pads, Writing Utensils, Web Links, Handouts and related items as provided in class.

Course Outline/Calendar

The date of coverage and order of coverage may be modified based on the faculty member and events beyond the control of faculty members that interfere with class times and teaching.

Week	Chapter/Topic/Lab
1: Introduction to Ion Notriding	• Topic: Overview of ion nitriding vs. other nitriding methods (gas and salt bath). • Objective: Understand the advantages of ion nitriding, including lower processing temperatures and reduced distortion. • Lab: Introduction to ion nitriding equipment and vacuum systems.
2: Basic Metallurgy For Notriding	• Topic: Review of steel metallurgy, crystal structures, and the effects of alloying elements (Cr, Al, Mo). • Objective: Explain how alloying elements influence nitride formation and case properties. • Lab: Metallographic preparation of steel samples for analysis.
3: The Plasma Environment and Process Physics	• Topic: Physics of glow discharge, plasma formation, and the roles of pressure, voltage, and gas mixture. • Objective: Learn how to manipulate plasma parameters to achieve different nitriding results. • Lab: Observe and analyze glow discharge and plasma characteristics in a live system.
4: Notrided Layer Formation and Properties	• Topic: The formation of the compound layer (white layer) and the diffusion zone. • Objective: Examine the metallurgical structure and understand the effects of layer composition on material properties (e.g., hardness and fatigue strength). • Lab: Microhardness testing and microscopic analysis of nitrided samples.
5: Cylinder Preparation and Fixturing	• Topic: The importance of pre-nitriding cleaning, rust removal, and proper fixturing for uniform treatment. • Objective: Prevent surface contamination and understand the thermal dynamics of fixturing cylindrical parts in the furnace. • Lab: Practice cleaning and fixturing cylindrical components for nitriding.

Week	Chapter/Topic/Lab
6: Case Depth and Harness Control fror Cylinders	• Topic: Controlling case depth and surface hardness to meet application-specific requirements for cylinders. • Objective: Optimize process parameters (time, temperature, gas mix) to achieve the desired case profile. • Lab: Run an ion nitriding cycle on test cylinders and measure case depth.
7: Masking and Selective Notriding	• Topic: Techniques for masking specific areas of a cylinder to prevent nitriding, using mechanical barriers and other methods. • Objective: Learn to treat only the required surfaces for applications that demand both hard and soft areas. • Lab: Perform a selective nitriding process on a cylinder using masking techniques.
8: Post-Notriding Inspection and Quality Control	• Topic: Detailed inspection methods for nitrided cylinders, including visual checks, dimensional stability, and metallurgical analysis. • Objective: Ensure parts meet all quality and performance specifications before use. • Lab: Conduct a post-treatment quality control session on a completed batch of cylinders.
9: Plasma Nitrocarburing (FNC)	• Topic: Introduce carbon-containing gas to the process to form a more ductile compound layer (plasma ferritic nitrocarburizing). • Objective: Understand how adding carbon affects the compound layer and improves corrosion resistance. • Lab: Run a plasma FNC cycle and compare the resulting layer properties to a standard ion nitriding cycle.
10: Process Optimization For Specific Cylinder Alloys	• Topic: Process parameters for specific alloys like stainless steels and specialized nitriding steels. • Objective: Optimize sputtering times and gas mixes to break down the passive oxide layer on stainless steel. • Lab: Treat cylinders made from different alloys and analyze the case formation.
11: Advanced Applications and Surface Modifications	• Topic: Combining ion nitriding with other surface treatments (e.g., PVD or CVD coatings) for multi-layer protection. • Objective: Explore applications where ion nitriding is used as a pre-treatment to enhance coating adhesion and performance. • Lab: Discuss case studies of multi-treatment applications and their benefits.
12: Furnace Technology and Maintenance	• Topic: In-depth look at furnace design, process controls, and preventative maintenance for ion nitriding equipment. • Objective: Learn to identify and address common equipment-related issues and ensure process consistency. • Lab: Perform routine maintenance and calibration checks on lab equipment.
13: Troubleshooting Common Nitriding Defects	• Topic: Analyze and diagnose common nitriding issues, such as low surface hardness, case exfoliation, and uneven nitriding. • Objective: Identify causes and implement corrective actions based on case studies. • Lab: Examine defective nitrided samples to determine the root cause of the problem.
14: Safety Protocols For Plasma Nitriding	• Topic: Review comprehensive safety procedures for working with vacuum equipment, high voltage, and process gases. • Objective: Emphasize personal protective equipment (PPE), fire hazards, electrical safety, and gas handling. • Lab: Conduct a safety review and emergency protocol drill in the lab environment.
15: Cylinder Design For Optimal Ion Nitriding	• Topic: Collaborating with design engineers to create cylindrical components that are optimized for the ion nitriding process. • Objective: Understand how factors like corner radii affect nitride uniformity and minimize potential chipping. • Lab: Evaluate and critique sample cylinder designs for manufacturability and nitriding success.
16: Final Review and Capstone Project	• Topic: Review all major course concepts, from metallurgy and process control to quality and troubleshooting. • Objective: Apply learned knowledge by completing a comprehensive capstone project that involves planning, executing, and analyzing an ion nitriding cycle for a specific cylindrical component.

Week	Chapter/Topic/Lab
	• Lab: Present capstone project results, including process parameters, metallurgical analysis, and quality control findings. • Final Exam