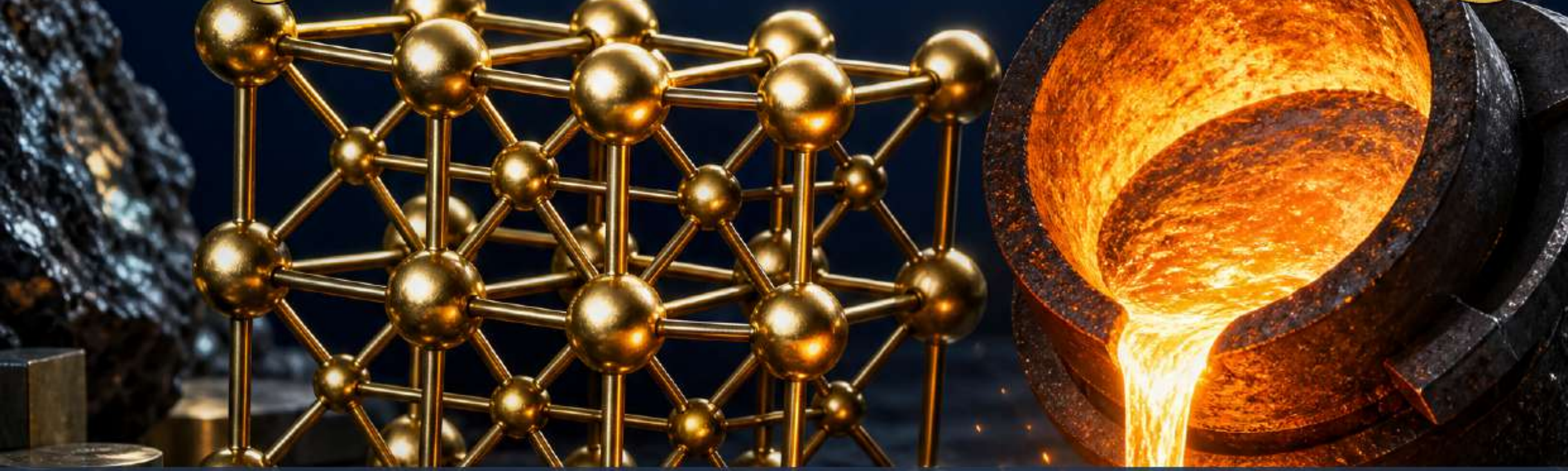
NARSIMHA REDDY ENGINEERING COLLEGE

(AUTONOMOUS)

MATERIAL SCIENCE AND METALLURGY

Project Based Learning



for II B.Tech I Semester - 2026-2027

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HOD

Department of Mechanical Engineering

Department of Mechanical Engineering
Material Science and Metallurgy (PBL)

1. Title: Comaprative study of ductile vs brittle materials using Universal Testing Machine

Description: In engineering applications, the selection of materials plays a crucial role in ensuring safety, reliability, and performance of components under different loading conditions. Materials are broadly classified into ductile and brittle based on their deformation and fracture characteristics. However, improper understanding of their mechanical behavior may lead to unexpected failures in real-world applications.

Need For the Project: Ductile materials (such as mild steel) undergo significant plastic deformation before fracture, providing warning prior to failure, whereas brittle materials (such as cast iron or glass) fracture suddenly without noticeable deformation. This difference in behavior necessitates a detailed experimental investigation.

Key Features:

Ductile Materials

- Undergo significant plastic deformation before fracture.
- Stress–strain curve shows a clear yield point and extended strain region.
- High toughness (large area under curve).
- Failure occurs gradually with necking.
- Absorb more energy before breaking → safer under dynamic/impact loads.
- Examples: Mild steel, copper, aluminum.

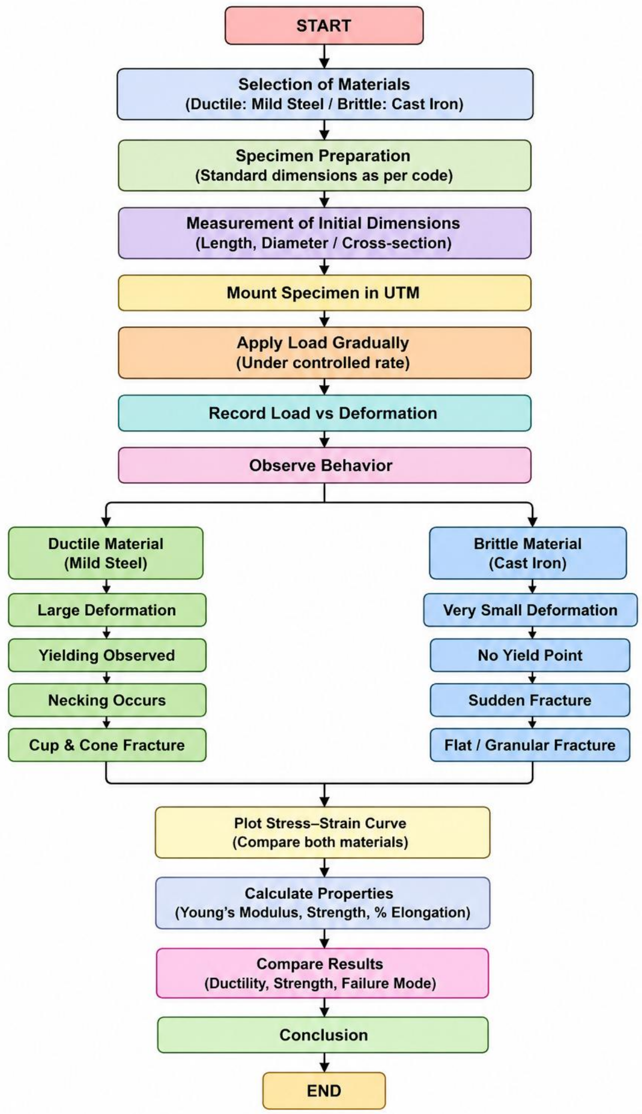
◆ Brittle Materials

- Fail with little or no plastic deformation.
- Stress–strain curve remains linear elastic until fracture.
- Low toughness (small area under curve).
- Sudden fracture without warning → risk of catastrophic failure.
- Absorb less energy before breaking → unsafe under impact loads.
- Examples: Cast iron, glass, ceramics.

◆ Comparative Outcomes (UTM Test)

- Ductile specimens: elongation, necking, gradual fracture.
- Brittle specimens: abrupt break, sharp fracture surface.
- Energy absorption capacity: ductile >> brittle.
- Applications:
  - Ductile → structural, load-bearing, dynamic load components.
  - Brittle → wear-resistant, compressive load applications.

Expected Outcome: The problem is to experimentally evaluate and compare the mechanical properties of ductile and brittle materials using a Universal Testing Machine (UTM) by conducting tensile tests. The study aims to analyze parameters such as: Stress–strain behavior.



2. **Title: To prepare and study the microstructure of silver using microscope**

Description: The mechanical, electrical, and thermal properties of metals are strongly influenced by their microstructure**,** including grain size, grain boundaries, and phase distribution. Silver, widely used in electrical contacts, jewelry, and precision instruments, requires a clear understanding of its internal structure to ensure optimal performance and durability. However, the microstructure of silver is not visible to the naked eye and requires proper specimen preparation and microscopic examination. Inadequate preparation techniques—such as improper polishing or etching—can lead to inaccurate observations and misinterpretation of grain structure.

Need for the Project

Understanding the microstructure of silver is essential to analyze its physical and mechanical properties. The arrangement of grains, grain boundaries, and phases in silver directly influences its strength, ductility, conductivity, and corrosion resistance. By preparing and examining the microstructure using a microscope, one can identify defects, impurities, and structural variations that may affect performance in practical applications. This experiment helps in developing skills in specimen preparation, polishing, and etching techniques, which are fundamental in metallurgical studies. It also provides insight into the relationship between microstructure and material behavior, which is crucial for quality control, material selection, and engineering applications.

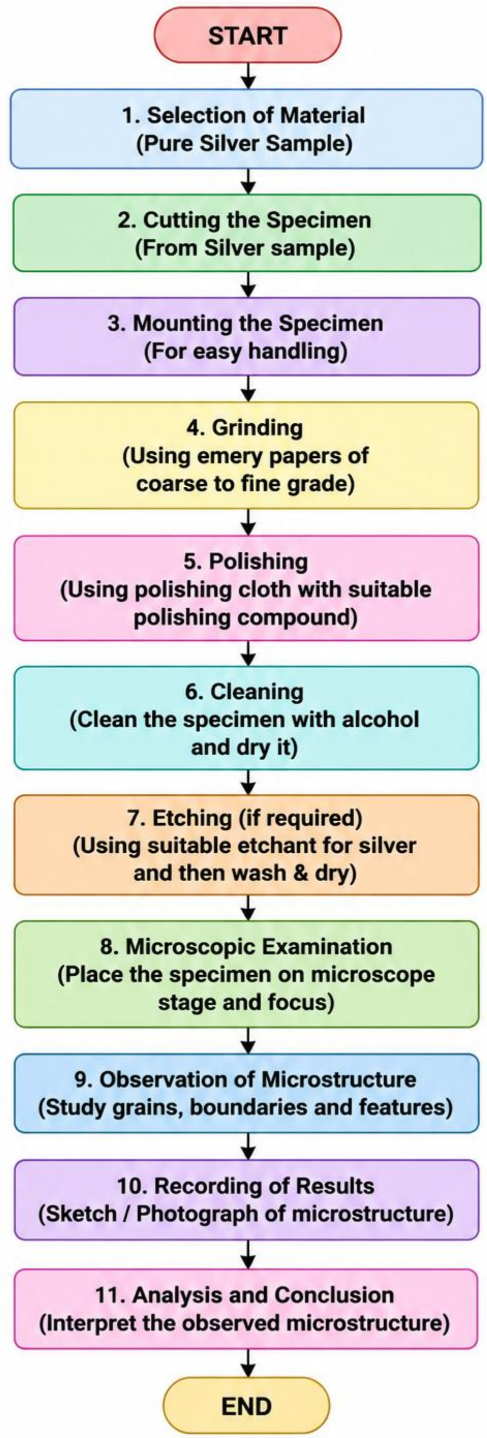
Key Features:

- Silver exhibits a face-centered cubic (FCC) crystal structure, which contributes to its high ductility and malleability.
- Presence of grains and grain boundaries that define the overall microstructure.
- Grain size and shape vary depending on processing methods like casting or annealing.
- Typically shows a single-phase structure in pure form without multiple phases.
- High reflectivity and brightness under the microscope due to its metallic nature.
- Annealed silver shows larger, equiaxed grains, while cold-worked silver shows elongated grains.
- Possible presence of twinning within grains due to deformation or recrystallization.
- Minimal defects and inclusions in high-purity silver samples.
- Grain boundaries appear as dark lines after etching, making the structure clearly visible.

Expected Outcome

The problem is to prepare a metallographic specimen of silver and study its microstructure using an optical microscope**.** This involves a sequence of steps including cutting, mounting, grinding, polishing, and etching,

PREPARE AND STUDY THE MICROSTRUCTURE OF SILVER USING MICROSCOPE



3. Title: To prepare and study the microstructure of muntz metal using microscope

Description: Muntz metal, a type of brass alloy consisting primarily of copper and zinc (typically 60% Cu and 40% Zn), is widely used in marine applications, ship sheathing, and engineering components due to its good corrosion resistance and mechanical strength. The performance of Muntz metal largely depends on its microstructure**,** particularly the distribution of α (alpha) and β (beta) phases**,** grain size, and grain boundaries.However, the internal structure of Muntz metal cannot be observed without proper metallographic preparation. Inadequate specimen preparation—such as improper grinding, polishing, or etching—can obscure important features like phase distribution and grain boundaries, leading to incorrect interpretation of material properties.The problem is to prepare a metallographic specimen of Muntz metal and study its microstructure using an optical microscope.

Need for the Experiment

Muntz metal, a brass alloy composed primarily of copper and zinc, is widely used in marine and engineering applications due to its good strength and corrosion resistance. Studying its microstructure is essential to understand the distribution of different phases, such as alpha (α) and beta (β) phases, which significantly influence its mechanical properties. By preparing and examining the microstructure using a microscope, one can observe grain structure, phase boundaries, and any defects or inclusions present in the material. This experiment helps in understanding the relationship between composition, microstructure, and properties of Muntz metal. It also develops practical skills in specimen preparation, polishing, and etching, which are crucial for metallurgical analysis, quality control, and material selection in engineering applications.

Key Features

- Muntz metal is a 60% copper – 40% zinc brass alloy commonly used in marine applications.
- Exhibits a duplex (two-phase) microstructure consisting of alpha (α) and beta (β) phases.
- Alpha phase (α): light-colored, soft, and ductile (copper-rich).
- Beta phase (β): darker, harder, and stronger (zinc-rich).
- Grain structure and grain boundaries are clearly visible after proper polishing and etching.
- Etching highlights phase distribution, making α and β phases distinguishable under the microscope.
- Grain size and phase proportion depend on composition and thermal/mechanical treatment.

Expected Outcome

The experiment involves systematic specimen preparation steps including cutting, mounting, grinding, polishing, and chemical etching

PREPARE AND STUDY THE MICROSTRUCTURE OF SILVER USING MICROSCOPE

START

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(From Silver sample)

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3. Mounting the Specimen
(For easy handling)

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4. Grinding
(Using emery papers of coarse to fine grade)

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5. Polishing
(Using polishing cloth with suitable polishing compound)

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6. Cleaning
(Clean the specimen with alcohol and dry it)

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7. Etching (if required)
(Using suitable etchant for silver and then wash & dry)

↓

8. Microscopic Examination
(Place the specimen on microscope stage and focus)

↓

9. Observation of Microstructure
(Study grains, boundaries and features)

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10. Recording of Results
(Sketch / Photograph of microstructure)

↓

11. Analysis and Conclusion
(Interpret the observed microstructure)

↓

END

4. **Title: To prepare and study the microstructure of phosphorous bronze using microscope**

Description: Phosphor bronze is widely used in engineering applications due to its excellent mechanical properties such as high strength, wear resistance, corrosion resistance, and good fatigue behavior. These properties are strongly influenced by its microstructure, including grain size, phase distribution, and the presence of alloying elements like phosphorus.The problem is to prepare a suitable metallographic specimen of phosphor bronze and study its microstructure using an optical microscope. This involves proper sectioning, mounting, grinding, polishing, and etching of the sample to clearly reveal its internal structure. The objective is to identify and analyze the microstructural features such as grain boundaries, phases, and any defects, and to correlate these features with the material's properties and performance.

Need for the Experiment

Phosphorous bronze is an important copper-based alloy containing tin and a small amount of phosphorus, known for its high strength, wear resistance, and excellent corrosion resistance. Studying its microstructure is essential to understand the distribution of phases, grain structure, and the effect of alloying elements on its mechanical properties. By preparing and examining the microstructure using a microscope, one can observe grain boundaries, phase variations, and any defects such as inclusions or segregation. This analysis helps in establishing the relationship between composition, microstructure, and material properties. The experiment also develops essential metallurgical skills such as specimen preparation, grinding, polishing, and etching. Understanding the microstructure of phosphorous bronze is crucial for quality control, material selection, and ensuring reliable performance in engineering applications such as bearings, springs, and electrical components.

Key Features:

- Phosphorous bronze is a copper–tin alloy with a small addition of phosphorus.
- Exhibits fine-grained microstructure due to the grain-refining effect of phosphorus.
- Predominantly shows alpha (α) phase structure (solid solution of tin in copper).
- May contain intermetallic compounds depending on tin content.
- Grain boundaries and grain size are clearly observed after etching.
- Etching improves contrast and reveals microstructural details under the microscope.
- Microstructure may show uniform or slightly segregated phases based on processing.
- Possible presence of defects such as inclusions or micro-porosity.
- Microstructure influences strength, hardness, wear resistance, and corrosion resistance.
- Requires systematic specimen preparation steps: cutting, mounting, grinding, polishing, and etching.
- Helps in understanding the structure–property relationship of the alloy.
- Useful in quality assessment and failure analysis of engineering components like bearings, springs, and electrical parts.

Expected Outcome

- Successful preparation of a smooth, scratch-free specimen surface through proper grinding and polishing.
- Clear observation of the microstructure under the microscope after etching.
- Identification of alpha (α) phase as the primary constituent of phosphorous bronze.
- Visualization of grain structure and grain boundaries.
- Observation of fine grains due to the presence of phosphorus.
- Detection of any phase variations, inclusions, or minor defects if present.
- Understanding of the effect of alloying elements (tin and phosphorus) on microstructure.
- Correlation between microstructure and mechanical properties such as strength, hardness, and wear resistance.
- Development of practical skills in specimen preparation techniques (cutting, mounting, grinding, polishing, etching).

PREPARE AND STUDY THE MICROSTRUCTURE OF SILVER USING MICROSCOPE

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3. Mounting the Specimen
(For easy handling)

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4. Grinding
(Using emery papers of coarse to fine grade)

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(Using polishing cloth with suitable polishing compound)

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6. Cleaning
(Clean the specimen with alcohol and dry it)

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7. Etching (if required)
(Using suitable etchant for silver and then wash & dry)

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8. Microscopic Examination
(Place the specimen on microscope stage and focus)

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9. Observation of Microstructure
(Study grains, boundaries and features)

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10. Recording of Results
(Sketch / Photograph of microstructure)

↓

11. Analysis and Conclusion
(Interpret the observed microstructure)

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END

5..Title: To prepare and study the microstructure of polymer using microscope

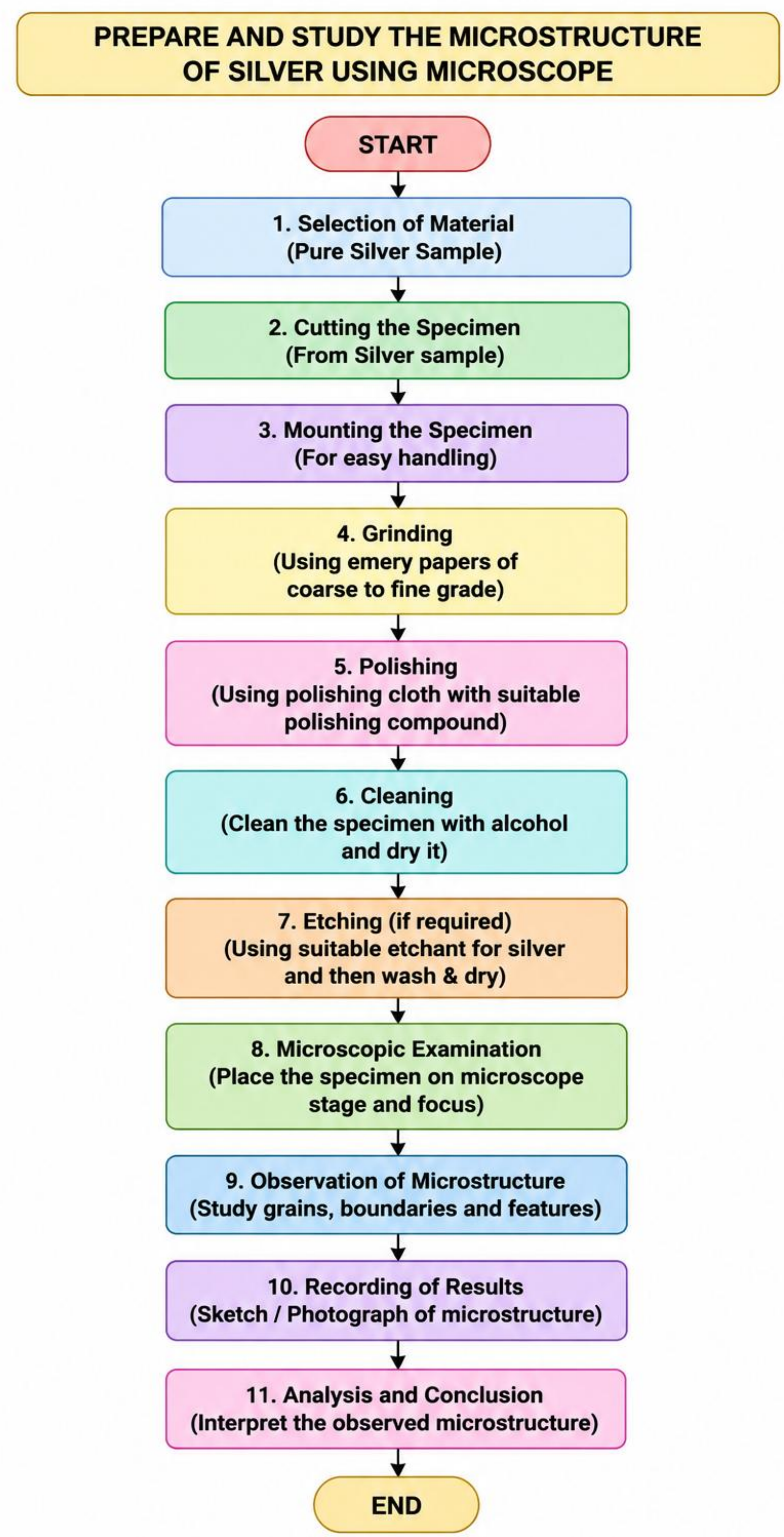
Description: Polymers are widely used in engineering and industrial applications due to their lightweight, flexibility, and diverse mechanical and thermal properties. These properties are significantly influenced by their microstructure, including the arrangement of polymer chains, degree of crystallinity, phase distribution, and presence of additives or fillers.The problem is to prepare a suitable specimen of a polymer material and study its microstructure using a microscope. This involves proper sample preparation techniques such as cutting, mounting (if required), surface finishing, and in some cases staining or etching to enhance contrast. The objective is to observe and analyze features such as crystalline and amorphous regions, spherulitic structures, voids, or inclusions, and to understand how these microstructural characteristics affect the overall behavior and performance of the polymer.

Need

Polymers are widely used engineering materials due to their lightweight nature, flexibility, and diverse range of properties. Studying the microstructure of polymers is essential to understand their internal structure, such as crystalline and amorphous regions, which significantly influence their mechanical, thermal, and optical properties. By preparing and examining polymer specimens under a microscope, one can observe features like spherulites, phase distribution, and structural irregularities. This analysis helps in understanding the relationship between processing conditions, structure, and properties of polymers. The experiment also develops essential skills in specimen preparation, handling, and microscopic observation techniques specific to polymer materials. Understanding polymer microstructure is important for material selection, quality control, and improving performance in applications such as packaging, automotive components, and biomedical devices.

Expected Outcome:

- Obtain a properly prepared, smooth polymer specimen suitable for microscopic examination.
- Clearly observe the microstructure of the polymer under the microscope.
- Identify amorphous and crystalline regions present in the material.
- Visualize spherulitic structures in semi-crystalline polymers, if applicable.
- Observe phase distribution and internal structural features.
- Detect defects such as voids, cracks, or inclusions, if present.
- Understand the effect of processing conditions on polymer structure.
- Correlate microstructure with properties like strength, flexibility, and optical behavior.
- Gain practical skills in handling and preparation of polymer specimens.
- Develop the ability to interpret microstructural features for quality control and applications.



6. **Title: To prepare and study the microstructure of ceramics using microscope**

Description: Ceramic materials are extensively used in engineering applications due to their high hardness, wear resistance, thermal stability, and corrosion resistance. These properties are strongly dependent on their microstructure, including grain size, grain boundaries, porosity, and the presence of different phases or impurities.The problem is to prepare a suitable ceramic specimen and study its microstructure using a microscope. This involves careful sample preparation techniques such as cutting, mounting, grinding, polishing, and in some cases thermal or chemical etching to clearly reveal the internal structure. The objective is to observe and analyze microstructural features such as grain morphology, porosity distribution, cracks, and phase composition, and to correlate these features with the mechanical and thermal properties of the ceramic material.

Need :

Ceramic materials are widely used in engineering applications due to their high hardness, wear resistance, thermal stability, and corrosion resistance. Studying the microstructure of ceramics is essential to understand features such as grain size, grain boundaries, porosity, and phase distribution, which significantly influence their mechanical and thermal properties. By preparing and examining ceramic specimens under a microscope, one can identify structural characteristics and defects such as pores, cracks, and inclusions that affect performance. This analysis helps in establishing the relationship between processing methods, microstructure, and properties of ceramic materials. The experiment also develops essential skills in specimen preparation, polishing, and etching techniques specific to brittle materials. Understanding ceramic microstructure is crucial for quality control, material selection, and improving the reliability of components used in applications such as refractories, electronics, and structural parts.

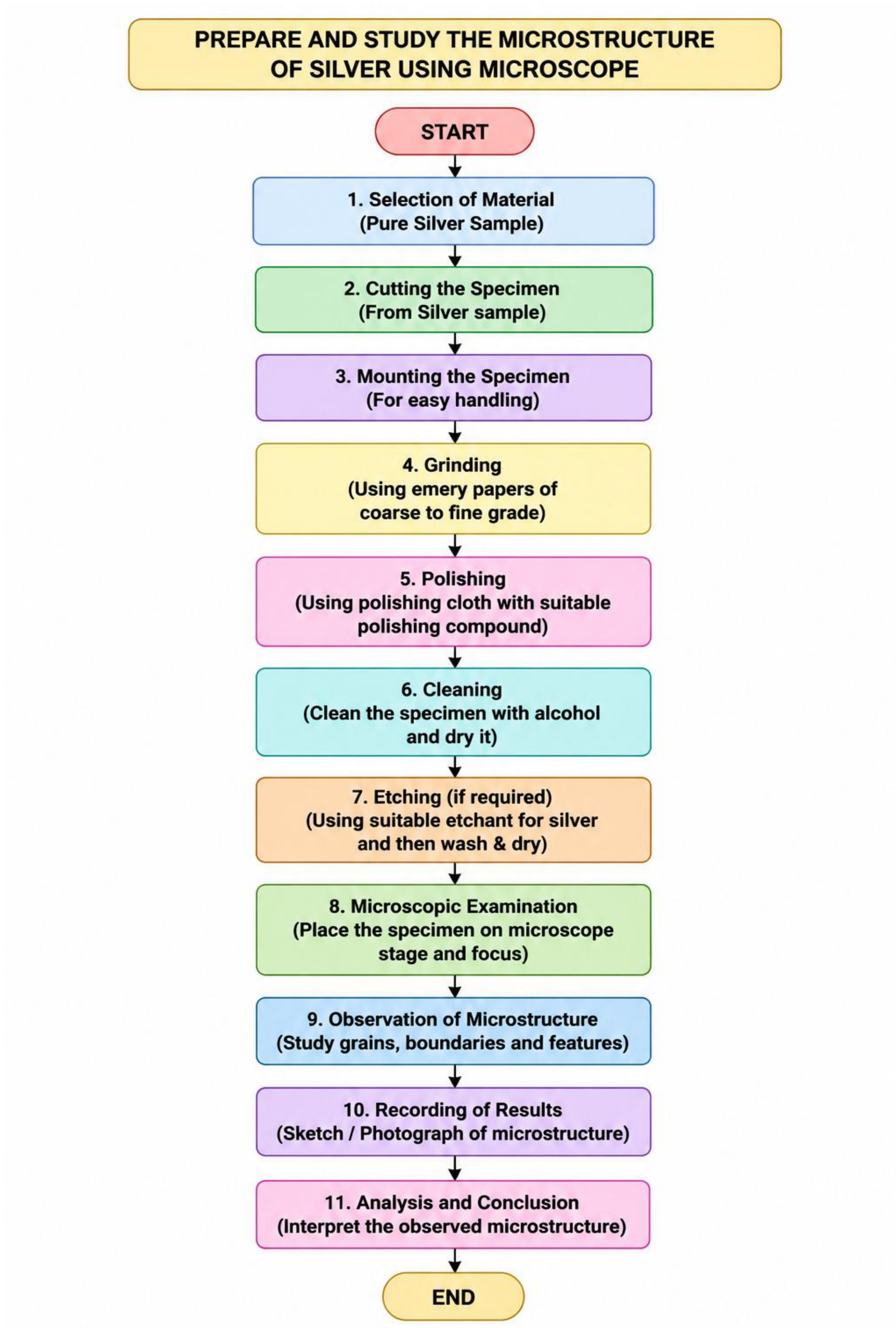
Key Features:

- Ceramics are inorganic, non-metallic materials with high hardness and brittleness.
- Microstructure consists of grains and grain boundaries.
- Presence of porosity (pores/voids) is a characteristic feature of many ceramics.
- May exhibit single-phase or multi-phase structures depending on composition.
- Grain size and distribution significantly influence strength and toughness.
- Grain boundaries play a key role in crack propagation.
- Possible presence of defects such as micro-cracks, inclusions, and pores.
- Etching enhances visibility of grains and boundaries under the microscope.
- Microstructure strongly affects mechanical, thermal, and electrical properties.
- Requires careful specimen preparation due to brittleness (cutting, mounting, grinding, polishing).

Expected outcome:

- To understand the grain size, shape, and distribution in ceramic materials.
- To identify phases, pores, cracks, and defects present in the material.
- To correlate microstructure with mechanical properties such as strength, hardness, and brittleness.
- To evaluate the quality of processing methods like sintering and heat treatment.
- To detect manufacturing flaws that may lead to failure in service.
- To support material selection and design for engineering applications.

- To enhance knowledge of structure–property relationships in ceramics.



7. **Title: To prepare and study the microstructure of nano materials using microscope**

Description: Nanomaterials exhibit unique mechanical, electrical, optical, and thermal properties due to their extremely fine structure at the nanometer scale. These properties are highly dependent on their microstructural features such as particle size, shape, distribution, agglomeration, and surface morphology.The problem is to prepare a suitable specimen of nanomaterials and study their microstructure using an appropriate microscope. This involves careful sample preparation techniques such as dispersion, mounting on suitable substrates, drying, and in some cases coating to enhance image quality. Advanced microscopic techniques may be required to clearly observe nanoscale features. The objective is to analyze characteristics such as particle size distribution, morphology, and uniformity, and to understand how these features influence the overall properties and performance of nanomaterials.

Need:

- To observe and analyze grain size, particle size, and morphology at the nanoscale.
- To identify nanostructures such as nanoparticles, nanowires, nanotubes, or thin films.
- To study surface characteristics and interfaces, which strongly influence nanomaterial behavior.
- To detect defects, agglomeration, and irregularities in synthesized nanomaterials.
- To correlate microstructure with unique properties like high strength, electrical conductivity, optical behavior, and catalytic activity.
- To evaluate the effectiveness of synthesis techniques (e.g., sol-gel, chemical vapor deposition, ball milling).
- To ensure quality control and uniformity in nanomaterial production.
- To support research and development in advanced applications such as electronics, biomedical devices, and energy systems.

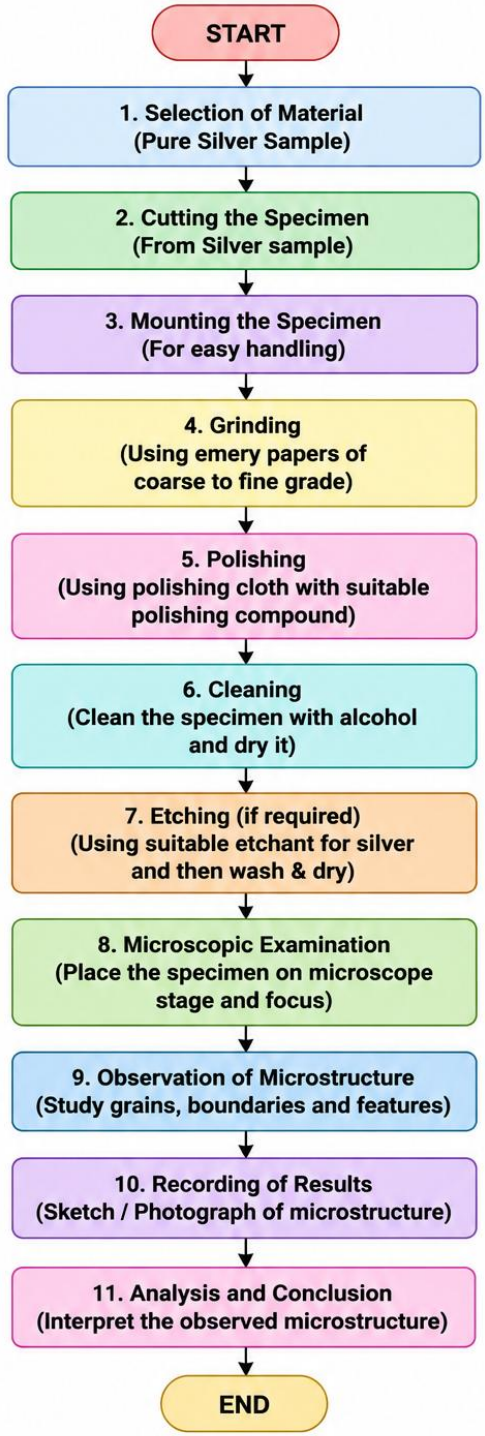
Key Features:

- Nanoscale Observation: Enables visualization of structures typically in the range of 1–100 nm.
- Advanced Microscopy Techniques: Use of high-resolution instruments such as Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM).
- Sample Preparation Methods: Involves specialized techniques like thin film preparation, coating (for SEM), and dispersion of nanoparticles.
- High Magnification and Resolution: Allows detailed examination of particle morphology and surface features.
- Morphological Analysis: Helps in identifying shape, size, and distribution of nanoparticles.
- Defect Identification: Detection of agglomeration, voids, dislocations, and other imperfections.
- Surface and Interface Study: Analysis of grain boundaries and interfaces critical for nanomaterial properties.

Expected outcome:

- Ability to prepare nanomaterial samples properly for microscopic examination (mounting, polishing, coating if required).
- Clear observation and identification of nanostructures such as nanoparticles, nanofibers, nanotubes, or thin films.
- Determination of particle size, shape, and distribution at the nanoscale.
- Understanding of surface morphology and texture of nanomaterials.
- Identification of defects, agglomeration, and grain boundaries in the material.
- Ability to correlate microstructure with physical and mechanical properties of nanomaterials.

PREPARE AND STUDY THE MICROSTRUCTURE OF SILVER USING MICROSCOPE



8. **Title: Analyze compressive strength of brittle materials like concrete**

Description: Brittle materials such as concrete are widely used in construction due to their high compressive strength but low tensile strength. The performance and safety of structures made from such materials depend largely on their ability to withstand compressive loads without failure.The problem is to analyze the compressive strength of a brittle material like concrete by conducting a compression test using a suitable testing machine. The study involves preparing standard test specimens, applying gradually increasing compressive load until failure, and recording the maximum load sustained. The objective is to determine the compressive strength, observe the mode of failure, and understand the behavior of brittle materials under compressive loading conditions. The results can be used to evaluate material quality and suitability for structural applications.

Need

- To determine the load-bearing capacity of brittle materials under compression.
- To evaluate the quality and grade of concrete used in construction.
- To ensure structural safety and reliability of buildings, bridges, and other structures.
- To study the failure behavior of brittle materials, which typically fail suddenly without significant deformation.
- To verify compliance with standard specifications and codes (such as IS standards).
- To assess the effect of mix proportions, curing conditions, and age on strength.
- To compare the performance of different materials or mix designs.
- To support design decisions in civil and structural engineering applications.

Key Features:

- Standardized Testing Procedure: Conducted as per codes such as IS 516 using defined specimen sizes (cube/cylinder).
- Compressive Loading: Load is applied gradually using a Compression Testing Machine (CTM) until failure occurs.
- Specimen Preparation: Involves proper mixing, casting, compaction, and curing of concrete samples.
- Controlled Loading Rate: Ensures accurate and consistent test results.
- Failure Characteristics: Sudden and brittle failure with crack formation and crushing of the specimen.
- Strength Calculation: Compressive strength is determined by maximum load divided by cross-sectional area.
- Influencing Factors: Results depend on water-cement ratio, curing time, aggregate properties, and mix proportions.
- Quality Assessment: Used to evaluate concrete grade and uniformity.
- Data Interpretation: Helps in comparing results with standard values and design requirements.
- Practical Relevance: Widely used in construction quality control and structural design validation.

PREPARE AND STUDY THE MICROSTRUCTURE OF SILVER USING MICROSCOPE

START

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1. Selection of Material
(Pure Silver Sample)

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2. Cutting the Specimen
(From Silver sample)

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3. Mounting the Specimen
(For easy handling)

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4. Grinding
(Using emery papers of coarse to fine grade)

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5. Polishing
(Using polishing cloth with suitable polishing compound)

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6. Cleaning
(Clean the specimen with alcohol and dry it)

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7. Etching (if required)
(Using suitable etchant for silver and then wash & dry)

↓

8. Microscopic Examination
(Place the specimen on microscope stage and focus)

↓

9. Observation of Microstructure
(Study grains, boundaries and features)

↓

10. Recording of Results
(Sketch / Photograph of microstructure)

↓

11. Analysis and Conclusion
(Interpret the observed microstructure)

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END

9. **Title: Analyze compressive strength of brittle materials like brick**

Description: Bricks are widely used as a fundamental construction material in buildings and civil engineering structures. As a brittle material, brick exhibits high compressive strength but fails suddenly without significant deformation. The strength and durability of masonry structures largely depend on the compressive strength of the bricks used.The problem is to analyze the compressive strength of brick by conducting a compression test using a suitable testing machine. This involves preparing standard brick specimens, applying a gradually increasing compressive load until failure, and recording the maximum load sustained. The objective is to determine the compressive strength of the brick, study its failure pattern, and assess its suitability for construction purposes. The analysis helps in ensuring quality control and adherence to standard specifications for safe structural applications.

Key Features: Analyze Compressive Strength of Brittle Materials (e.g., Concrete)

- Standardized Testing Procedure: Conducted as per codes such as IS 516 using defined specimen sizes (cube/cylinder).
- Compressive Loading: Load is applied gradually using a Compression Testing Machine (CTM) until failure occurs.
- Specimen Preparation: Involves proper mixing, casting, compaction, and curing of concrete samples.
- Controlled Loading Rate: Ensures accurate and consistent test results.
- Failure Characteristics: Sudden and brittle failure with crack formation and crushing of the specimen.
- Strength Calculation: Compressive strength is determined by maximum load divided by cross-sectional area.
- Influencing Factors: Results depend on water-cement ratio, curing time, aggregate properties, and mix proportions.
- Quality Assessment: Used to evaluate concrete grade and uniformity.
- Data Interpretation: Helps in comparing results with standard values and design requirements.
- Practical Relevance: Widely used in construction quality control and structural design validation.

Expected Outcome:

- . Ability to prepare brick specimens correctly for compressive strength testing.
- Determination of the compressive strength of brick using a Compression Testing Machine (CTM).
- Understanding of the load at failure and calculation of strength (load/area).
- Observation of failure pattern, such as cracking and crushing behavior typical of brittle materials.
- Ability to compare obtained results with standard specifications (e.g., IS codes for bricks).

PREPARE AND STUDY THE MICROSTRUCTURE OF SILVER USING MICROSCOPE

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11. Analysis and Conclusion
(Interpret the observed microstructure)

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END

10.**Title: Analyze compressive strength of brittle materials cast iron**

Description: Cast iron is a commonly used brittle engineering material known for its high compressive strength, good wear resistance, and ease of casting. However, due to its brittle nature, it exhibits negligible plastic deformation and fails suddenly under excessive load. Understanding its compressive behavior is essential for applications where it is subjected to compressive forces.The problem is to analyze the compressive strength of cast iron by conducting a compression test using a suitable testing machine. This involves preparing a standard specimen, applying a gradually increasing compressive load until failure or significant deformation occurs, and recording the maximum load sustained. The objective is to determine the compressive strength, observe the mode of failure, and study the stress–strain behavior of cast iron under compressive loading. The results help in evaluating its suitability for engineering applications subjected to compressive stresses.

Need:

- To determine the maximum compressive load capacity of cast iron.
- To understand the mechanical behavior of brittle materials under compressive forces.
- To study the failure characteristics, such as cracking and sudden fracture without significant deformation.
- To evaluate the quality and integrity of cast iron components.
- To support design and material selection in applications like machine bases, pipes, and engine blocks.
- To ensure safety and reliability of components subjected to compressive loads.
- To compare the compressive strength with other brittle materials like concrete and ceramics.
- To analyze the effect of microstructure, impurities, and casting defects on strength.

Key Features

- Standard Testing Method: Conducted using a Compression Testing Machine (CTM) following relevant standards.
- Specimen Preparation: Requires properly machined cylindrical or cubical cast iron specimens with smooth, parallel faces.
- Axial Compressive Loading: Load is applied gradually and uniformly along the axis until failure.
- Controlled Loading Rate: Maintains accuracy and repeatability of results.
- High Compressive Strength: Cast iron exhibits greater compressive strength than tensile strength.
- Brittle Failure Behavior: Failure occurs suddenly with crack initiation and propagation, without significant plastic deformation.
- Strength Calculation: Compressive strength is determined by maximum load divided by original cross-sectional area.

Expected Outcome:

- Ability to prepare and test cast iron specimens under compressive loading using a Compression Testing Machine (CTM).
- Determination of the ultimate compressive strength of cast iron.
- Understanding of the load–deformation behavior of brittle materials under compression.
- Observation of failure characteristics, such as sudden fracture and crack propagation.
- Ability to calculate compressive strength (maximum load / cross-sectional area).
- Identification of the influence of microstructure (graphite flakes), impurities, and casting defects on strength.
- Comparison of compressive strength with tensile behavior, highlighting the brittle nature of cast iron.
- Development of skills in recording, analyzing, and interpreting experimental data.

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(Interpret the observed microstructure)

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