

## **A Proposal for Characterization of Materials**

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### **I. Objectives of the Virtual Lab**

The virtual lab has following objectives

- Impart quality experiments on basic and some advanced aspects on characterization of materials.
- Correlation of theory with experiments since, characterization is ‘part-and-parcel’ of any materials science and metallurgical course in the country.
- Provide both breadth and depth on the basic materials characterization (XRD, SEM and TEM)
- The experiments using sophisticated facilities will provide the students knowledge on capability and usage of these facilities.

### **II. List of experiments**

(A Virtual Lab consists of 7-10 experiments\*)

1. Determination of Crystal Structure using power X-ray diffraction
2. Determination of Crystallite Size of a polycrystalline sample using X-ray diffraction
3. Determination of Precious Lattice Parameter of FCC and BCC phases using X-ray diffraction
4. Advanced Imaging modes of SEM (BSE (Compositional & Topograpgy), TLD, Multiple Elemental mapping and Selected area electron channeling, EBSD)
5. Quantitative X-ray Metallography using Electron Microprobe Analyzer [Compositional Measurements of Steels (plain carbon, stainless, tool, high speed, interstitial free steels)]
6. Advanced Imaging in TEM (centered dark field, weak beam dark field, HAADF, high resolution)
7. Interpretation of Selected area Diffraction Patterns (spots vs. ring, effect of defect structure)
8. Observation and interpretation of defect structure in cold rolled aluminum, copper and zinc
9. Measurements of dislocation density in cold rolled metals
10. Estimation of Precipitation size and Precipitate Volume Fractions in Age hardenable alloys

\*Alternatively, 3-4 additional experiments (minimum) may be developed to augment existing labs ([www.vlab.co.in](http://www.vlab.co.in)).

1. X-ray Fluoresce microscopy for determination of chemical composition of materials (metals, alloys, ceramics)
2. Electron Microprobe analyses of alloy for precise determination of chemical composition
3. Determination of stacking fault energy in FCC alloys

**Note:** Please list all related experiments available on the web (vlab.co.in) and compare your proposed experiments with them. Please justify why the proposed experiments are needed and exactly what gaps they fill.

The experiments proposed (12+3=15) provided both width and depth of basic materials characterization techniques (XRD, SEM and TEM) in materials science and metallurgical engineering. The students pursuing bachelor of engineering are, in general provided theoretical knowledge on these subjects but are not exposed to experiments using these instruments. The experiments, in general will fill the gap created due to non-exposure of these facilities in various universities/institutes but also provide the basis of understanding and correlating the theory with experiments. The lack of technical expertise available, sometime becomes a bottleneck. The efforts will be made to explain the fundamental aspects of these experiments, followed by detailing of the experiments using sophisticated tools available at IIT Kanpur. Hence, both quality (data, experiments, expertise) as well as quantity (12-15 experiments) will be provided by this exercise. Some of these experiments even will provide answers to real time challenges faced by the regular students and students involved industrial problems of materials development and correlation with properties. These experiments are proposed in such a way that students who have done the course on Basic Electron Microcopy. Some of these experiments are advanced level and some are basic experiments.

### III. **Target group of users**

- ~~— UG (1<sup>st</sup> Year/ 2<sup>nd</sup> Year) [highest priority for development]~~
- **UG (3<sup>rd</sup> Year/ 4<sup>th</sup> Year) [next higher priority for development] {even 1<sup>st</sup>/2<sup>nd</sup> of M.Tech and Phd students}**

### IV. **Mapping of proposed lab with AICTE courses as per [attached list](#) of potential labs**

- [Material Characterization \(101\), Material Characterization Laboratory 106\)](#)

### V. **Mapping of proposed lab with universities** (minimum 3 universities)

- [National Institute of Technology, Ceramic Engineering, CR3203 Instrumental Characterization Laboratory](#)
- [National Institute of Technology, Metallurgical and Materials Engineering, MM3521 Characterization of Materials Laboratory](#)
- [University of Hyderabad, School of Engineering & Technology, MS315 Materials Characterization Laboratory](#)
- [School of Materials Science and Technology, IIT \(BHU\), MS222 \(Materials Characterization\)](#)
- [Punjab Engineering College, MTN465, Materials Characterization](#)

### VI. **Expected timelines**

Presentation of proposal to domain experts' committee –[31<sup>st</sup> March 2022](#)

Demo of First 3 Expts and Review – [30<sup>th</sup> June 2022](#)

Demo of 5-6 Expts and review – [31<sup>st</sup> August 2022](#)

Demo of 7-10 Expts and review – 31<sup>st</sup> October 2022

Final demo of 7-10 Expts – 15<sup>th</sup> November 2022

Hosting of lab (7-10 Expts) – 30<sup>th</sup> November 2022

Note 1: The [LDC](#) will coordinate the [reviews](#) and [hosting](#)

Note 2: The lab is supposed to be developed and hosted within 6 - 9 months from the date of approval

VII. **Budget** (Max. Rs 2 Lakhs per experiment with a ceiling of Rs 20 Lakhs per Lab)

**Table I. Budget for Characterization of Materials**

| S. No.       | Equipment/Activity  | Budget #<br>(In Rupees) |
|--------------|---|-------------------------|
| 1            | Laptop / Machine  | 6                       |
| 2            | Manpower  | 4.5                     |
| 3            | Consumables   | 5.0                     |
| 4            | Contingency   | 1.5                     |
| 5            | Honorarium for Lab Developer (Rs 20k per experiment; Ceiling of Rs 2 Lakhs per lab) | 2                       |
| 6            | Miscellaneous   | 1                       |
| <b>TOTAL</b> |   | <b>20.00</b>            |

# To be released based on the recommendation of the review committee

**Note:** Institute overheads not to be included in the budget

VIII. **Justification of the budget requirements**

(a) Details of Laptop/Machine

For recording and editing we need 1 laptop and high resolution camera recorder with required software.

(b) Details of Manpower (number, cost per man-months etc.)

For arrangement of the experiments and logistics, one project associate is required.

a. Total man-months required : 9 months

b. No. of project staff, cost per man-months : 1 project staff and Rs 25,000/- per man-month

c. Honoraria for other staff associated with the project : nil

(c) Details of Consumables

Lab consumables (samples, sample prep.,) and gas, O-rings, etc are needed.

- (d) Details of Miscellaneous cost : User charge of the machines (XRD, SEM and TEM)
- a. Internal Review (Optional, Rs 1000 per experiment) : Yes
- ~~b. Field Trials~~
- c. Others : Xeroxing, postage etc

IX. **Student Feedback and Learning**

- How will you collect feedback and use them?
- Student Reaction via online tools will be utilized to get the feedback of the students for each experiment.
- What is the actual learning component provided by the Virtual Lab?  
Fundamental understanding on the subject matter and correlation of the theory with experiments
- After the Virtual Lab experience, would the student be able to perform the experiment in the real lab?  
Yes. This will require them to visit the hosting institute.

**ANNEXURE-I**

Important information for the development of Virtual Labs

(A Virtual Lab consists of 7-10 experiments)

X. **Link to some sample virtual labs**

<https://python-iitk.vlabs.ac.in/>      <https://cs-iitd.vlabs.ac.in/>      <https://plchla-coep.vlabs.ac.in/>

XI. **Technology Used**

- For Web interface (should be Free and Open-Source Software): Yes
- For back-end (should be Free and Open-Source Software) : Yes

XII. **Required Components for virtual experiments**

- Step-by-step procedure
- Online manual
- Pre-test
- Simulator
- Post-test
- Related resources
- Additional help