Course Aims:
1. Basic elements of surface science important for materials and catalysis research
2. Physical and chemical methods important for research in surface science, material science and catalysis are considered and their application is demonstrated on practical examples

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Practical Description:

Learning Objectives for Students:
- Develop hands-on experience with major characterization techniques introduced in the lectures
- Plan experiments for open-ended questions
- Advance written and oral communication skills through report-writing and brief presentation

Project Description & Objectives:

Each group will receive a set of 4 samples that they will characterize using the relevant experimental techniques. The goal of the project is to develop familiarity with sample preparation and data interpretation for experimental techniques applied to a specific type of catalytic material (e.g. zeolites).

Project HS2024

Each group will receive four versions of a zeolite material. These samples will exhibit different characteristics due to different synthesis conditions, thermal treatments, etc. Using the relevant techniques, groups will characterize the samples to determine how these samples differ from each other. Based on the characteristics of the materials, students will propose what treatments these samples have undergone, as well as potential catalytic applications from a brief literature search.

Suggested Report Template:

1. Title & Abstract (200 words)
   a. A brief summary of the project's aims as well as the key result and conclusion

2. Introduction (< 1,000 words)
   a. Project aims
   b. Background & literature survey

3. Methods (< 2 pages, double spaced)
   a. Description of each experimental method used and sample preparation

4. Results (< 10 pages, double spaced including figures)
   a. Report findings from various methods
   b. Summarize in concise and clean figures

5. Discussion (< 5 pages, double spaced)
   a. Interpret results with regards to the project aims
   b. Q1: What impact does each treatment have on the characteristics of the samples? How can you rationalize these changes?
   c. Q2: Multiple methods can give complementary information - compare similar information obtained by different methods and comment on the strengths or limitations of each method.
   d. Q3: Based on the findings, propose a relevant catalytic application of one or more of the studied samples. What properties are important and how does the material meet the requirements of the specified application.

6. Conclusions (< 500 words)
   a. Summarize project aims and key results, with main take-away message

7. Outlook (< 3 pages, double spaced)
   Q1: What additional techniques or experiments using the techniques above could contribute to your understanding of the material. Detail the type of information you would expect to gain and propose how you might plan the experiment.
   Q2: What changes to the material would you make to further improve the material for the recommended application?

8. References

Group Presentation:

15-20 minute presentation summarizing the project aims, main results, and conclusion with a 5 minute question and answer period. Assistants will be in attendance.

Software Guide:

    Data & Plotting:

        Origin [free through ETH Software]

        OR   Matlab [free through ETH Software]

    Experimental Methods:

        NMR:

        MestReNova [free through ETH Software]

        OR   TopSpin (Bruker) [free license available]

    Referencing Software:

        Mendeley [free account through ETH address]

        OR   EndNote [free through ETH Software]