Fall-2025

SURFACE ANALYSIS: Chemical characterization

Practical work for Fall 2025-26

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A group of students has to face the following surface analytical request described below.
The tasks are:

- Analyse the problem, identify needs.
- Propose a surface analysis strategy to solve the issue.
- Analyse the obtained data in order to extract the appropriate information
- Prepare a short presentation (15 minutes) of the accomplished work and present it.

1. Si_3N_4 PVD coating (Group of 2-3 students)

Introduction: Silicon nitride coatings exhibit excellent mechanical, thermal, electrical and chemical properties that can be exploited in numerous engineering applications. In electronics it is used insulator layer for integrated circuits.
The case: a producer wants to check the quality of two thin PVD Si_3N_4 layers deposited onto Si wafers that are characterised by a bad and good electrical behaviour but different coloration. Of particular interest are: contaminations by carbon or oxygen, the stoichiometry of the coating (Si to N ratio) and the possible presence of contamination/stoichiometry deviations the Si_3N_4/Si interface.

2. Corrosion of Stellite alloys (Group of 2-3 students)

Introduction: Stellite alloy are Co-Cr matrix-based alloys containing carbides. These alloys exhibit outstanding friction and wear properties associated to high corrosion resistance in aqueous media and at high temperature. They find application in the biomedical sector, nuclear power reactor and chemical installations.
The case: A Stellite alloy containing tungsten and molybdenum carbides (site 1-10 μm) surrounded by a CoCr matrix are exposed to oxidation in high temperature boiling water. In these conditions the CoCr matrix develops a thin passivating oxide layer on its surface. The question is to know whether the carbides also develop such film, and if yeas of which composition.

3. Iron-mineral interaction (Group of 2-3 students)

Introduction: Metal surfaces can undergo significant chemical changes when subjected to electrochemical treatments, especially in the presence of natural materials such as bentonite clay– a type of soil rich in silicate minerals. These treatments may lead to the deposition of clay-derived species onto the Fe surface, potentially altering its surface chemistry and reactivity. Understanding these changes is essential for applications in environmental remediation, corrosion science, and surface engineering.
The case: A pure-iron sample is subjected to an electrochemical treatment in the presence of bentonite clay. This process is expected to result in the formation of a surface layer composed of species derived from the clay. To investigate the nature of this deposited layer, a spectroscopy technique will be employed to analyze the elemental and chemical states present on the treated Fe surface. The resulting spectra will be compared with those of untreated bentonite clay to identify similarities and differences in elemental composition and bonding environments. The question is to determine the nature of the deposited layer and its interaction with the Fe substrate, based on the comparative analysis.