Characterization of Polymeric Materials

Course at a Glance
Basic concepts of chemical, physical and mechanical characterization techniques, with special focus on polymeric materials.

Instructors
Jose Alejandro Heredia-Guerrero  jose.guerrero@iit.it
Luca Ceseracciu   luca.ceseracciu@iit.it
Nanophysics Department, Istituto Italiano di Tecnologia

Credits: 4

Synopsis
Polymers are ubiquitous materials in multiple fields of industry and research. Their extensive range of properties facilitates their use in very diverse applications. In this PhD course, we show the main techniques and methodologies in the characterization of their useful properties as materials. This characterization includes the determination of the chemical composition and structure and the potential reactivity as well as the determination of the polymeric structure and its implication on the final properties.
In this context, the size and the form of the macromolecules are key parameter.
Through a combination of mechanical characterization techniques it is possible to give a comprehensive description of the deformation mechanisms of polymers, from elastic deformation to plasticity and fracture, taking into account the influence of factors such as temperature, time and scale. The mechanical parameters will include classical uni-axial stress-strain behavior, toughness and fracture toughness, creep, dynamic behavior, hardness, with special focus on nanoindentation.
The objective of this course is to describe the experimental techniques used for this characterization. The approach is very applied, starting from the theory for each technique and leading to practical strategies to the test design and interpretation of results.

Syllabus
The course develops in about 12 hours in the classroom.
Chemical characterization: main spectroscopy techniques, such us UV/VIS, infrared and Raman spectroscopies and nuclear magnetic resonance;
Structural characterization: the order of the macromolecules in terms of amorphous and crystalline domains will be depicted. Standard methods for the determination of the polymeric structures will be described.
Determination of molecular weight of polymers: the number and weight average molecular weight and the distribution of molecular weights will be explained and the usual methodologies for their determination will be described.
Mechanical behavior of polymers: deformation mechanisms, uni-axial testing, hardness, toughness measurements
Nanoindentation: fundamentals, analysis methods, practical applications
The examination consists in a written test.

Reading list

Course date
from 4 to 8 May 2015