**TABELLA A**

| Insegnamento/docente | CFU | Sem | Descrizione del corso |
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| *Nanostrutture di carbonio per l'energia*<br>*Prof. Mauro Riccò* | 2 | 1 | The course is primarily concerned with providing the basic knowledge onnanostructured materials consisting of carbon only as: Fullerenes,Graphene, Nanotubes, Nanographites and Onions. The study of thesematerials is a frontier field of modern research and the reached todayknowledge of these systems suggests that they may form the basis ofmany future technological applications. Their expertise should thereforebe an important basis for the formation of the future physicist andchemist who deals with condensed matter but not only. |
| *Proprietà magnetiche dei materiali dal nano al macro*<br>*Prof. Massimo Solzi*<br>*Dott.ssa Franca Albertini* | 2 | 2 | These lectures provide an overview of the basic properties of magnetically ordered solid materials and their explanation in atomic terms. In addition, the effects of fundamental interactions on the magnetic phenomenology at the different length scales will be highlighted. The students will become familiar with the main concepts, effects and definitions, which constitute the necessary basis for understanding the current topics of modern magnetism. These concepts will be adopted for explaining the magnetic and multi-functional properties of some emerging classes of magnetic materials in frontier applications in the fields of energy, biomedicine and information technology.<br><br>Some of the main covered topics are:<br>• Magnetic moments in free atoms and ions, diamagnetism<br>• Assembly of atoms, paramagnetism<br>• Exchange interactions and ferromagnetism<br>• Magnetism in metals<br>• Anti-ferromagnetism, ferrimagnetism and non collinear order<br>• Crystal field effects and magnetic anisotropy<br>• Magnetic domains and the magnetization process<br>• Magnetic materials for energy conversion applications<br>• Magnetic thin films and nanostructures<br>• Relevant lenghtscales in magnetism<br>• Superparamagnetism, interface and surface anisotropy<br>• Magnetic materials for biomedical applications |
| *Introduzione alla spettroscopia Raman*<br>*Prof. Matteo Masino* | 1 | 2 | Description of light scattering and Raman scattering. Resonance Ramanintensity in the framework of the Albrecht's theory. Micro-Raman mapping, SERS and TERS phenomena. Comparison of the different techniques. |

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| *Proprietà di trasporto dei semiconduttori.*<br>*Prof. Antonella Parisini* | 2 | 1 | The course offers an introduction to transport properties in semiconductors, focusing on inorganic semiconductors with tetrahedral coordination. The electric charge conduction in this class of materials will be discussed in the light of the occupancy of electrically active impurities,of the electronic transport mechanisms, of compensation effects. The role of electronic properties of semiconductors in device design will be discussed, considering the effects of both shallow impurities and deep levels. Experimental methods for the investigation of low-field transportproperties will be discussed, with the possibility of visiting research laboratories and assisting in measurements. It will be possible to proposeinsights on specific topics, in relation to the interests expressed by the students, such as: transport at high electric fields, classical and quantum magneto-transport or transport through p-n junctions. The areas towards which research on semiconductors is mainly oriented today willbe outlined. |
| *Tecniche di analisi per materiali nanostrutturati, amorfi e policristallini*<br>*Prof. Lara Righi* | 2 | 1 | Amorphous, nanocrystals and crystals. Definition of amorphous, glassy,nanostructured and polycrystalline materials. 0D, 1D 2D and 3D structures and impact on physical and chemical properties. Introduction on some systems for the production of confined size materials. Materials characterization techniques from bulk to amorphous. Thermal analyses: DSC, TGA, DTA: description of the techniques and principles underlyingthe thermal analyzes. Application on glass, amorphous and nanomaterials, phase transformations. Diffraction techniques. Fundamental theoretical bases of diffraction of crystalline materials: X- rays, synchrotron light, and neutrons. Description of the large facilities(synchrotrons and neutron sources). In situ diffraction experiments: study of phase transformations, crystallization, unconventional experimentalconditions. Microscopy techniques: SEM scanning electron microscopy:SEM functioning and applications to real cases. TEM Transmissionelectron microscopy: basic principles and some examples from biological samples to inorganic materials. Surface microscopy: AFM (Atomic Force Microscopy): description of the technique a applications. In perspective: environmental impact and sustainability of nanotechnologies. |
| *Tecniche avanzate di fluorescenza*<br>*Prof. Cristina Sissa* | 1 | 2 | Time resolved emission spectroscopy (fluorescence and phosphorescence). Fluorescence anisotropy. Optical spectroscopy ofmolecular crystals. Electroluminescence and photovoltaic effect. Thetopics will be integrated by case histories. |
| *Tecniche di microscopia elettronica per i materiali.*<br>*Prof. Laura Lazzarini* | 2 | 1 | Introduction to the importance of the Electron Microscopy techniques inMaterials Science Basics of the Microscope Operation: magnetic lenses, resolution, lens defects. Scanning versus Transmission mode. Diffraction contrast in TEM images. The diffraction pattern. Two-beam condition. Defects imaging. Chemical sensitive imaging. Phase contrast: Principles of the phase contrast. High Resolution Electron Microscopy. The importance of the simulations. TEM related techniques: Scanning TEM (Z-contrast), X-ray microanalysis, Energy Loss Spectroscopy, Cathode- luminescence. Applications: Defects and compositional contrast in low dimensional hetero structures; identification of new crystal phases by means of the STEM-HAADF technique; high resolution cathode- luminescence spectroscopy on single nanostructures. |

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| *Sintesi e caratterizzazione di materiali porosi organici*<br>*Prof. Alessandro Pedrini* | 2 | *2* | The course will highlight the principal methodologies for the synthesis and characterization of porous organic materials, such as covalent organic frameworks (COFs), porous aromatic frameworks (PAFs) and polymers of intrinsic microporosity (PIMs). The focus will be placed on relevant applications in gas adsorption and separation and water treatment. |
| *Materiali polimerici sostenibili*<br>*Prof. Roberta Pinalli* | 1 | *2* | Biodegradable, compostable and recyclable polymers represents one of the frontiers of material chemistry research. This course will highlight thesynthesis, the properties and principal applications of bio-based,biodegradable and compostable polymers. Moreover, the use of covalent adaptable networks to impart recyclability to thermoset will bediscussed. |