Matteo Leoni

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Current position

Assistant Professor in nanomaterials at the Metallurgy and Microstructures lab, University of Trento - Faculty of Engineering - Department of Materials Engineering and Industrial Technologies

Academic career

- assistant professor c/o University of Trento, Department of Materials Engineering and Industrial Technologies (I), from 2001;
- post-doc c/o University of Trento, Department of Materials Engineering and Industrial Technologies (I), 2001;
- post-doc c/o Max-Planck Institut für Metallforschung - Abteilung Mittemeijer, Stuttgart (D), 1999;
- PhD in Materials Engineering (dottorato di ricerca in Ingegneria dei Materiali, University of Roma "Tor Vergata"), with a curriculum in surface engineering, 1999;
- Research contractor in the Microstructure/XRD lab at the University of Trento (1995);
- entitled to exercise the profession of Engineer after State examination hold in 1995;
- graduated in Ingegneria dei Materiali (Materials Engineering) with full votes (110/110 cum laude) at the University of Trento (TN, Italy), with a thesis on "Determinazione sperimentale degli stress residui in rivestimenti ceramici" (Experimental determination of residual stresses in ceramic coatings) in 1995;
- undergraduated at the Istituto Tecnico Industriale (Technical-Industrial Institute) "G. Marconi" of Rovereto (TN, Italy) in "Elettronica e Telecomunicazioni progetto AMBRA" (Electronics, Telecommunications and Computer science, experimental project AMBRA) with full votes (60/60);

Main teaching activity

- invited professor: Université du Maine - Le Mans (F), 2007 and 2008; teaching basic and advanced X-ray diffraction for the analysis of materials
- invited professor: ENSAM Metz / Aix en Provence (F), 2004; teaching of micromechanics and advanced X-ray diffraction
- chair of the course "Nanostructured Materials", University of Trento, Laurea Magistralis in Materials Engineering, since 2006;
- professor at the International School of Doctoral Studies in Materials Science and Engineering (courses of Mechanics of Materials and Nanomaterials, both of them held yearly), University of Trento, since 2002;
- teaching activity in the courses of "Scienza dei Materiali VO", "Scienza dei Materiali I", "Scienza dei Materiali II" (Materials science, three different courses, various levels), University of Trento, since 2001;
- professor for the course of "Analisi Matematica II" (Advanced mathematics course), University of Trento, academic year 2000/2001;
- teaching at several international schools and workshops on the use of X-ray diffraction for materials analysis;

- teacher at various courses on computer hardware/software, basic and advanced C, C++, Delphi, Pascal, Assembler (x86 and Z80) language programming for local private companies, since 1993;

Awards

"Premio Mario Nardelli" of the AIC (Associazione Italiana di Cristallografia) in 2010. The citation for the prize was 'Per i suoi contributi originali allo studio delle microstrutture in vari tipi di materiali condotte con metodi di diffrazione di polveri nano cristalline e allo sviluppo di tali metodologie'

European Powder Diffraction Committee (EPDIC) Award 2002. The citation for the prize was for 'outstanding scientific contribution in the field of powder diffraction'

ENEL (National Institute for Electrical Energy, national supplier of electric power) award 1998: national winner;

Current language skills

Italian: mother tongue; English: fluent; French: fluent; German: good; Spanish: elementary

Membership

Member of the International X-ray Analytical Society (IXAS), European Crystallographic Association (ECA), Associazione Italiana di Cristallografia (AIC), British Crystallographic Association (BCA), Deutsche Gesellschaft für Kristallographie, International Center for Diffraction Data (ICDD).

European Technical Co-chair, Fellow and Grant in Aid committee chair of the ICDD.

Refereeing

Referee for international Journals in the field of applied crystallography and materials science/engineering among which: Journal of Applied Crystallography, Acta Crystallographica, Powder Diffraction, Zeitschrift für Kristallographie, Thin Solid Films, Surface and Coatings Technology, Materials Science and Engineering, Journal of the American Ceramic Society, Journal of Applied Physics, Geotechnique, European Journal of Mineralogy, Nature, Electrochemistry Communications, Journal of Nuclear Materials, Materials Chemistry and Physics.

Main scientific interests and experience

Powder diffraction; experience with traditional techniques (Bragg-Brentano and Parallel Beam diffraction, Grazing Incidence Diffraction, Surface diffraction (Crystal Truncation Rods measurements), Reflectometry, Texture and Residual Stress analysis) and non-traditional ones (neutron diffraction, synchrotron radiation diffraction in traditional and grazing geometry, development of new techniques for the measurement of through-thickness stress fields by diffraction and by combination of destructive and non-destructive techniques). Development of new micromechanical models compatible with the microstructure of the material for residual stress measurement in thin films and bulk specimens.

Applied X-ray diffraction: activity in pattern modeling (Rietveld and Rietveld-related methods, new methodologies of full pattern analysis, namely Whole Powder Pattern Fitting and Whole Powder Pattern Modeling), Line Profile Analysis (both traditional and new methods) and relative non-structural applications of Rietveld analysis (LPA embedded in the Rietveld code). Quantitative phase analysis and tentative structure solution of complex amorphous/semicrystalline magnetic metallic glasses and small structures (<200 atoms). Development and evaluation of new line-profile standards for

powder diffraction (KCl, LaB_6). Development of a new algorithm and the corresponding code for the modeling of surface relaxation phenomena occurring in nanometer-sized powders within a full diffraction pattern approach.

Instrument development: hardware, electronics and software project of a 4 point bending tool for *in situ* direct measurement of X-ray elastic constants in small test-samples for a Philips X'Pert MRD diffractometer. Project of a reaction chamber for *in situ* study of surface reactions (both by reflectometry, diffraction and CTR scan) to be mainly used on synchrotron radiation facilities.

Computer-assisted diffraction analysis and Computational Materials Science: development of a computer program for the analysis of multilayer structures (especially substrate-film, substrate-oxide, substrate-intermixed layer-film-passivating oxide and similar structures). Development of a code for full pattern analysis of materials microstructure (implementing the WPPF, WPPM and surface relaxation models recently developed, cf. list of recent publications). Development of the DIFFaX+ code for the refinement of faulted layered structures (e.g. minerals, clays, etc.) and modular materials. Development of routines for fast calculation of atom-atom correlations (Pair Distribution Function) for calculation via Debye method.

Materials/nanomaterials: ball milling and its effects on defectivity of metals and oxides. Nano-sized materials for power production and storage (lithium-based batteries, zirconia/ceria for SOFCs, copper oxides for solar cells). Materials for electro- and photo-catalysis: nano-sized platinum crystals and multiple-doped TiO_2.Surface reactivity of minerals and nano-sized powders. Structural/ microstructural analysis of nano-sized powders (synthetic nano-chrysotile from hydrothermal synthesis, ceramic sol-gel powders & quantum dots, nanostructured metals, nanostructured grains produced from amorphous metals). Novel low cost/high performance bioactive scaffolds from fossils.

Coatings: thermal barrier coatings (e.g. stabilized zirconia). Hard protective films (diamond, carbides, nitrides). Films for solid-state gas sensors (e.g. SnO_2, TiO_2). Production and characterization of RF magnetron sputtered thin films for wear protection, microelectronics etc.

Major current research topics

- Correlation between structure, microstructure, properties and application in nanostructured and layered (modular) materials
- Development of new models for microstructural analysis of nanostructured materials from powder diffraction data based on micromechanics and on a description of layer faults in terms of an interference function.
- Development of the PM2K code for Whole Powder Pattern Modeling (WPPM) and of the DIFFaX+ code for the refinement of faulted, modular and <3D periodic structures;
- Development of copper-based materials and inks for low-cost solar energy conversion;
- Novel stabilized Grätzel cells based on modified clays;
- Novel materials based on poly-substituted titania and tailored microstructure for electro and photocatalysis;
- Matching between computational Materials Science and X-ray diffraction measurements: investigation of inconsistencies and development of novel fast algorithms;
- Development and in situ (on leaf) evaluation of the performance of nanostructured agrochemicals;
- Novel anti-hail agents based on nanostructured mixed iodide formulations;
- Diffraction studies of the structure/microstructure of novel biomedical materials based on fibroin and collagen;
- Radioactive nano-ferrites for cancer therapy;

- Diffractometric studies of the relationships between structure/ microstructure and the macroscopic behavior of thin films and thick coatings;
- Surface reactivity of sol-gel nano-sized powders subjected to extensive ball milling and its effects on powder solubility;
- *In situ* mesoscopic (ESEM study) and microscopic (X-ray diffraction) analysis of microstructure and its evolution in natural and functionalized materials and cements;

Publications

More than 100 publications in International peer reviewed journals.
More than 100 participations to national and international conferences
Scores (ISI web of science)

h-index: **19**
Total number of citations: **> 1400**
Average citation per article: **> 9**