

# GIOVANNI MARIA VANACORE



## PERSONAL DETAILS

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Nationality: Italian

Date and place of birth: November 27th 1983, Milano (Italy)

Work address: Department of Materials Science, University of Milano-Bicocca,  
Via Cozzi 55, 20125 Milano (Italy).

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## PROFESSIONAL EXPERIENCES

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### Assistant Professor of Physics – Department of Materials Science, University of Milano-Bicocca (Italy)

*Period:* December 2019 – present

Principal Investigator of the ‘Laboratory of Ultrafast Microscopy for Nanoscale Dynamics’ (LUMiNaD).

### Scientist – École Polytechnique Fédérale de Lausanne (Switzerland)

*Period:* February 2016 – November 2019; *Advisor:* Prof. Fabrizio Carbone.

Ultrafast electron diffraction, microscopy and spectroscopy experiments performed in the LUMES laboratory. The appointment was partially supported by the EPFL Fellowship program co-founded by Marie Skłodowska-Curie (H2020 – MSCA – COFUND 2016, GA n. 665667).

### Post-doctoral Research Scholar – California Institute of Technology (U.S.A.)

*Period:* November 2011 – January 2016; *Advisor:* Prof. Ahmed H. Zewail (Nobel Laurate in Chemistry - 1999).

The research activity was focused on the investigation of the nature of atomic-scale ultrafast phenomena in nanomaterials.

### M.Sc. internship at the French Atomic Energy Commission, CEA-Saclay (France)

*Period:* March 2007 – September 2007; *Advisor:* Dr. Nicholas Barrett.

Investigation of surface properties of correlated perovskite materials. My appointment was supported within the framework of the FP6 INCEMS European project.

## TEACHING EXPERIENCES

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### Teaching assistant - École Polytechnique Fédérale de Lausanne (Switzerland)

*Period:* March 2016 – November 2019.

“Physique Generale II” (code: PHYS-106(a)). Spring of 2016, 2017 and 2018. Instructor: Prof. Fabrizio Carbone.

“Solid State Physics I” (code: PHYS-309). Fall of 2018. Instructor: Prof. Henrik Rønnow.

“Physique Generale I” (code: UNIL-112). Spring of 2019. Instructor: Prof. Fabrizio Carbone.

### Teaching assistant - California Institute of Technology (U.S.A.)

*Period:* March 2015 – June 2015.

“Dynamics and Complexity in Physical and Life Sciences” (code: Ch 228). Spring of 2015.

Instructor: Prof. Ahmed H. Zewail.

### Teaching assistant – Politecnico di Milano (Italy)

*Period:* March 2008 – September 2011.

“Fundamentals of Experimental Physics” (code: 081389, 12 credits, spring of 2009).

“Fundamentals of Thermodynamics and Acoustics” (code: 085646, 5 credits, spring of 2011).

Instructor: Prof. Alberto Tagliaferri.

## EDUCATION

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### Ph.D. in Physics (Italian/French joint degree)

**Politecnico di Milano (Italy) - École Polytechnique X (France) - CEA-Saclay (France)**

*Period:* January 2008 – October 2011.

*Advisors:* Prof. Alberto Tagliaferri, Dr. Nicholas Barrett, Prof. Henri-Jean Drouhin.

Investigation of electronic and structural properties of semiconductor nanostructures for optoelectronics applications using spectro-microscopy techniques.

*Thesis title:* Investigation of Ge Surface Diffusion and SiGe Nanostructures by Spectro-microscopy Techniques.

*Final grade:* “avec mention très honorable”.

### M.Sc. in Physics Engineering – Politecnico di Milano (Italy)

*Period:* September 2005 – December 2007.

Major in Photonics and Nanotechnology. *Final grade:* 110/110 *magna cum laude*.

### Alta Scuola Politecnica (ASP)

**Politecnico di Milano and Politecnico di Torino (Italy)**

*Period:* September 2005 – February 2008.

Diploma in Management of Innovation.

### M.Sc. in Mathematics Engineering – Politecnico di Torino (Italy)

This degree has been obtained thanks to the successful completion of the ASP program.

### B.Sc. in Physics Engineering – Politecnico di Milano (Italy)

*Period:* September 2002 – July 2005.

Major in laser physics and condensed matter physics. *Final grade:* 110/110 *magna cum laude*.

### Scientific High School Diploma – Angri, Salerno (Italy)

*Period:* September 1997 – July 2002.

*Final grade:* 100/100.

## SCIENTIFIC RESULTS AND REVIEWING ACTIVITIES

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- Author and co-author of 33 scientific publications and 1 book chapter.
- Hirsch (h)-index: 14 (from Scopus).
- Reviewer activity for the following journals: *Science Advances*, *New Journal of Physics*, *Nano Letters*, *ACS Photonics*, *Structural Dynamics*, *Ultramicroscopy*, *Advances in Physics: X*, *Physica Status Solidi (Rapid Research Letters)*.
- Review panel member for student admission to the Bachelor of Science in Materials Science, University of Milano-Bicocca, Italy.
- International evaluator for the “Émergence Call for Proposals 2021-2022”, Sorbonne University, France.
- International evaluator for the “VENI research programme 2021” of the Dutch Research Council, The Netherlands.

## INSTITUTIONAL RESPONSABILITIES

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- Faculty member, Department of Materials Science, University of Milano-Bicocca, Italy (Period: 2019 – present).
- Member of the Managing Committee of the Microscopy Platform; Materials Science advisor and Electron Microscopy specialist, University of Milano-Bicocca, Italy (Period: 2019 – present).
- Member of the Erasmus Committee; Materials Science advisor, University of Milano-Bicocca, Italy

(period: 2020 – present).

- Member of the Orientation Committee; Materials Science advisor, University of Milano-Bicocca, Italy (Period: 2020 – present).

## MEMBERSHIP OF SCIENTIFIC SOCIETIES

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2018 – present. Member of the American Chemical Society (ACS) – member n. 31011858.

2021 – present. Member of the American Physical Society (APS) – member n. 62074153.

2021 – present. Member of the Materials Research Society (MRS).

## TECHNICAL SKILLS

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- Ultrafast Electron Diffraction (UED), Ultrafast Electron Microscopy (UEM) and Ultrafast Electron Energy-Loss Spectroscopy (Femto-EELS).
- Femtosecond Lasers and Non-linear Optics.
- Transmission electron microscopy (TEM), Scanning electron microscopy (SEM) and Scanning Auger Microscopy (SAM).
- Angle-resolved Photoemission (ARPES) and Photo-electron emission microscopy (PEEM).
- Scanning probe microscopies (AFM and STM).
- Optical microscopy and Raman spectroscopy.
- *Softwares and Programming Languages*: Matlab, Mathematica, Solidworks, Simlon, Comsol, OpenFOAM, Abinit, C/C++, LabView.

## LANGUAGES

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- **Italian**: native language.
- **English**: fluent, working language.
- **French**: fluent, working language.

## FELLOWSHIPS, GRANTS AND AWARDS

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- *May 2021*. Scientific coordinator and principal investigator of the FET-OPEN project entitled “Ultrafast all-optical spatio-temporal electron modulators: opening new frontiers in electron microscopy (SMART-electron, GA n. 964591)” funded by the European Union for 3.042 milion euro.
- *November 2018*. Accepted grant proposal as co-PI entitled “*Project Heidi: Stimulated Nuclear Excitation by Electron Capture*”. Founding source: Google Inc (final award of 400000 USD).
- *March 2018*. Italian National Academic Qualification as Associate Professor in Experimental Physics of Matter (FIS 02/B1).
- *March 2016*. Accepted grant for the EPFL’s international postdoctoral fellowship programme co-founded by Marie Skłodowska-Curie (March 2016, H2020 – MSCA – COFUND 2016, GA n. 665667).
- *February 2016*. Accepted grant within the ACHN-2015 funding scheme of the Agence Nationale pour la Recherche (ANR), France. Awarded in February 2016 (400000 Euro), application withdrawn after winning.
- *September 2011*. Award for the “*Best oral presentation at the XCVII Conference of the Italian Physical Society*” (L’Aquila, Italy) in the Condensed Matter Physics session.
- *July 2010*. Accepted experiment proposal at the SOLEIL Synchrotron (Paris, France), entitled "Electronic Structure of Ge nanostructures by Resonant k space-PEEM" (experiment n. 20100485). (July 2010)

- *July 2009.* Accepted experiment proposal at the ESRF Synchrotron (Grenoble, France), entitled "Nano-diffraction mapping and predictive modelling of the strain in single artificial SiGe nanostructures" (experiment n. SI-1873). (July 2009)
- *January 2008.* Medal of Excellence as "Best M.Sc. Graduate Student in Physics Engineering in 2006-2007" at Politecnico di Milano (Italy).
- *January 2008.* Ph.D. Fellowship of the Italian Ministry of Education, University and Research. (January 2008 – February 2011).

## **SEMINARS AND TALKS AT INTERNATIONAL CONFERENCES**

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- Invited talk at the International Online Workshop on "Electrons, Photons and Plasmons 2021", March 10-12, 2021.
- Invited colloquium at the Department of Physics of the University of Arizona (USA). (Oct. 2020)
- Invited talk at the 3rd International Workshop on "Electron Beam Spectroscopy for Nanophotonics", Paris (France). (Sept. 2019)
- Invited talk at the 14th Femtochemistry Conference – Dynamics of the Complexity in Chemistry, Biology and Physics, Shanghai (China). (August 2019)
- Invited talk at the International Conference on Quantum Imaging and Electron Beam Shaping (QSORT Conference-2019), Erlangen (Germany). (July 2019)
- Contributed talk at the WE-Heraeus-Seminar on "Ultrafast Quantum Phenomena in the Near Field" at the Physikzentrum Bad Honnef (Germany). (March 2019)
- Invited seminar at the New Jersey Institute of Technology (NJIT), Newark (New Jersey, USA). The seminar was part of the interview process for Assistant Professor position in Physics. (February 2019)
- Invited talk at the 9th Annual meeting of the NCCR-MUST 2019, Grindelwald (Switzerland). (Jan. 2019).
- Invited talk at the 256th meeting of the American Chemical Society (ACS) within the session "Ultrafast Molecular Sciences by Femtosecond Photons & Electrons: Symposium in honor of Ahmed Zewail", Boston (USA). (August 2018)
- Contributed talk at the XXI International Conference on Ultrafast Phenomena (UP2018), Hamburg (Germany). (July 2018)
- Invited talk at the conference "From Solid State to Biophysics IX: From Basic to Life Sciences", Cavtat (Croatia). (June 2018)
- Invited talk at the International Conference on Electron Beam Shaping in Space and Time (QSORT Conference-2018), Jülich (Germany). (May 2018)
- Invited seminar at the University of California Irvine (UCI), Irvine (California, USA). The seminar was part of the interview process for Assistant Professor position in Physical Chemistry. (April 2018)
- Invited talk at the 4th International Conference on Ultrafast Structural Dynamics (ICUSD-2017), Trieste (Italy). (Dec. 2017)
- Invited talk at the 2nd International Workshop on "Electron Beam Spectroscopy for Nanophotonics", Barcelona (Spain). (Oct. 2017)
- Invited talk at the 6th International Workshop on "Epitaxial Growth and Fundamental Properties of Semiconductor Nanostructures", Como (Italy). (Sept. 2017)

- Invited talk at the International Conference on "Quantum physics in Complex Matter: Superconductivity, Magnetism and Ferroelectricity (Superstripes 2017)", Ischia (Italy). (June 2017)
- Contributed talk at the workshop on "Electron Microscopy with High Temporal Resolution (EMHTR-2017)", Strasbourg (France). (May 2017)
- Invited talk at the 2017 Materials Research Society (MRS) meeting, Phoenix (United States of America). (April 2017).
- Contributed talk at the 5th Banff Meeting on Structural Dynamics, Alberta (Canada). (Jan. 2017)
- Invited talk at the 7th Annual meeting of the NCCR-MUST 2017, Grindelwald (Switzerland). (Jan. 2017).
- Invited talk at the "4th Italian Experience in Biomedical Research: Young Minds at Work", Desenzano del Garda (Italy). (Nov. 2016)
- Invited talk at the EMN Meeting on Photonics 2016, Barcelona (Spain). (Sept. 2016)
- Invited talk at the International Conference on "Quantum in Complex Matter: Superconductivity, Magnetism and Ferroelectricity (Superstripes 2016)", Ischia (Italy). (June 2016)
- Invited talk at the conference "From Solid State to Biophysics VIII: From Basic to Life Sciences", Cavtat (Croatia). (June 2016)
- Contributed talk at the 19th International Vacuum Congress (IVC-19), Paris (France). (Sept. 2013).
- Invited talk at the National Conference on Condensed Matter Physics - FisMat2013, Milano (Italy). (Sept. 2013)
- Contributed talk at the XCVII Conference of Italian Physical Society, L'Aquila (Italy). (Sept. 2011)
- Contributed talk at 28th European Conference on Surface Science (ECOSS-28), Wroclaw (Poland). (Sept. 2011)
- Contributed talk at the European Conference on Surface Crystallography and Dynamics 10 (ECSCD-10), Reading (UK). (Sept. 2010)
- Contributed talk at the 3rd International Conference on Nanostructures SELF-Assembly (NanoSEA) 2010, Cassis (France). (July 2010)
- Contributed talk at the 8th edition of International Workshop on Epitaxial Semiconductor on Patterned Substrates and Novel Index Surfaces (ESPS-NIS), Como (Italy). (June 2010)
- Contributed talk at the 26th edition of the European Conference on Surface Science (ECOSS-26), Parma (Italy). (Sept. 2009)

## LIST OF PUBLICATIONS

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34. **G. M. Vanacore**, I. Madan & F. Carbone,  
Spatio-temporal shaping of a free-electron wave function via coherent light–electron interaction.  
**La Rivista del Nuovo Cimento** (2020)
33. X. Fu, F. Barantani, S. Gargiulo, I. Madan, G. Berruto, T. LaGrange, L. Jin, J. Wu, **G. M. Vanacore**, F. Carbone & Y. Zhu  
Nanoscale-femtosecond dielectric response of Mott insulators captured by two-color near-field ultrafast electron microscopy

***Nature Communications* 11, 5770 (2020)**

32. I. Madan\*, **G. M. Vanacore\***, S. Gargiulo, T. LaGrange, and F. Carbone, (\*authors contributed equally)  
The quantum future of microscopy: Wave function engineering of electrons, ions, and nuclei,  
***Appl. Phys. Lett.* 116, 230502 (2020)**
31. **G. M. Vanacore**, G. Berruto, I. Madan, E. Pomarico, P. Biagioni, R. J. Lamb, D. McGrouther, O. Reinhardt, I. Kaminer, B. Barwick, H. Larocque, V. Grillo, E. Karimi, F. J. García de Abajo, F. Carbone,  
Ultrafast generation and control of an electron vortex beam via chiral plasmonic near-fields,  
***Nature Materials* 18, 573-579 (2019)**
30. I. Madan\*, **G. M. Vanacore\***, E. Pomarico, G. Berruto, R. J. Lamb, D. McGrouther, TTA Lummen, T. Latychevskaia, F. J. García de Abajo, F. Carbone, (\*authors contributed equally)  
Ultrafast holography enabled by quantum interference of ultrashort electrons,  
***Science Advances* 5, eaav8358 (2019)**
29. **G. M. Vanacore**, I. Madan, G. Berruto, K. Wang, E. Pomarico, R. J. Lamb, D. McGrouther, I. Kaminer, B. Barwick, F. J. García de Abajo, F. Carbone,  
Attosecond coherent control of free-electron wave functions using semi-infinite light fields,  
***Nature Communications* 9, 2694 (2018)**
28. K. Wang\*, **G. M. Vanacore\***, E. Pomarico, I. Madan, G. Berruto, F. J. García de Abajo, I. Kaminer, and F. Carbone, (\*Authors contributed equally)  
Photon-Induced Far-Field and Near-Field Electron Microscopy,  
in Conference on Lasers and Electro-Optics, OSA Technical Digest (online) (Optical Society of America, 2018),  
paper STh1N.4.
27. E. Pomarico, I. Madan, G. Berruto, **G. M. Vanacore**, K. Wang, I. Kaminer, F. J. García de Abajo, and F. Carbone,  
meV Resolution in Laser-Assisted Energy-Filtered Transmission Electron Microscopy,  
***ACS Photonics* 5, 759-764 (2018).**
26. G. Berruto, I. Madan, Y. Murooka, **G. M. Vanacore**, E. Pomarico, J. Rajeswari, R. Lamb, P. Huang, A. J. Kruchkov, Y. Togawa, T. LaGrange, D. McGrouther, H. M. Rønnow, and F. Carbone,  
Laser-Induced Skyrmion Writing and Erasing in an Ultrafast Cryo-Lorentz Transmission Electron Microscope,  
***Phys. Rev. Lett.* 120, 117201 (2018)**
25. **G. M. Vanacore**, J. Hu, W. Liang, S. Bietti, S. Sanguinetti, F. Carbone, and A. H. Zewail,  
Ultrafast atomic-scale visualization of acoustic phonons generated by optically excited quantum dots,  
***Structural Dynamics* 4, 044034 (2017).**
24. F. Pennacchio, **G. M. Vanacore**, G. F. Mancini, M. Oppermann, R. Jayaraman, P. Musumeci, P. Baum, and F. Carbone,

Design and implementation of an optimal laser pulse front tilting scheme for ultrafast electron diffraction in reflection geometry with high temporal resolution,  
**Structural Dynamics 4**, 044032 (2017).

23. J. Hu, **G. M. Vanacore**, A. Cepellotti, N. Marzari, and A. H. Zewail,  
 Rippling ultrafast dynamics of suspended 2D monolayers, graphene,  
**Proc. Natl. Acad. Sci. U.S.A.** **113**, E6555-E6561 (2016).  
 (Highlighted in **Nature Review Materials** doi:10.1038/natrevmats.2016.90)
22. **G. M. Vanacore**, A. W. P. Fitzpatrick, and A. H. Zewail,  
 Four-dimensional electron microscopy: ultrafast imaging, diffraction and spectroscopy in materials science and biology,  
**Nano Today 11**, 228-249 (2016).
21. J. Hu, **G. M. Vanacore**, Z. Yang, X. Miao, and A. H. Zewail,  
 Transient structures and possible limits of data recording in phase-change materials,  
**ACS Nano 9**, 6728-6737 (2015).
20. **G. M. Vanacore**, R. van der Veen, and A. H. Zewail,  
 Origin of axial and radial expansions in carbon nanotubes revealed by ultrafast diffraction and spectroscopy,  
**ACS Nano 9**, 1721-1729 (2015).
19. A. W. P. Fitzpatrick, **G. M. Vanacore**, and A. H. Zewail,  
 Nanomechanics and intermolecular forces of amyloid revealed by four-dimensional electron microscopy,  
**Proc. Natl. Acad. Sci. U.S.A.** **112**, 3380-3385 (2015).
18. M. Chaigneau, **G. M. Vanacore**, M. Bollani, G. Picardi, A. Tagliaferri, and R. Ossikovski, 20-nm-resolved stress profile in SiGe nano-strips obtained by tip enhanced Raman spectroscopy, in **Handbook on enhanced spectroscopies** by Marc Lamy de la Chapelle, Pietro Giuseppe Gucciardi, Nathalie Lidgi-Guigui, Pan Stanford Publishing, July 2015.
17. **G. M. Vanacore**, G. Nicotra, M. Zani, M. Bollani, E. Bonera, F. Montalenti, G. Capellini, G. Isella, J. Osmond, A. Picco, F. Boioli, and A. Tagliaferri,  
 Delayed plastic relaxation limit in SiGe islands grown by Ge diffusion from a local source,  
**J. Appl. Phys.** **117**, 104309 (2015)
16. **G. M. Vanacore**, J. Hu, W. Liang, S. Bietti, S. Sanguinetti, and A. H. Zewail,  
 Diffraction of quantum dot reveals nano-scale ultrafast energy localization,  
**Nano Letters 14**, 6148-6154 (2014).  
 (cover article – see figure on the right)



15. W. Liang, **G. M. Vanacore**, and A. H. Zewail,  
Observing (non)linear lattice dynamics in graphite by ultrafast Kikuchi diffraction,  
*Proc. Natl. Acad. Sci. U.S.A.* **111**, 5491 (2014).  
(Highlighted in *Nature Physics* **10**, 332 (2014))
  
14. **G. M. Vanacore**, M. Zani, M. Bollani, E. Bonera, G. Nicotra, J. Osmond, G. Capellini, G. Isella and A. Tagliaferri,  
Monitoring the kinetic evolution of self-assembled SiGe islands grown by Ge surface thermal diffusion from  
a local source,  
*Nanotechnology* **25**, 135606 (2014).
  
13. M. Bollani, S. Bietti, C. Frigeri, D. Chrastina, K. Reyes, P. Smereka, J.M. Millunchick, **G. M. Vanacore**, M.  
Burghammer, A. Tagliaferri, S. Sanguinetti,  
Ordered arrays of embedded Ga nanoparticles on patterned silicon substrates,  
*Nanotechnology* **25**, 205301 (2014).
  
12. A. W. P. Fitzpatrick, U. J. Lorenz, **G. M. Vanacore**, and A. H. Zewail,  
4D Cryo-Electron Microscopy of Proteins,  
*J. Am. Chem. Soc.* **135**, 19123-19126 (2013).
  
11. **G. M. Vanacore**, M. Chaigneau, N. Barrett, M. Bollani, F. Boioli, M. Salvalaglio, F. Montalenti, N. Manini, L.  
Caramella, P. Biagioni, D. Chrastina, G. Isella, O. Renault, M. Zani, R. Sordan, G. Onida, R. Ossikovski, H.-J.  
Drouhin, and A. Tagliaferri,  
Hydrostatic strain enhancement in laterally confined SiGe nano-stripes,  
*Phys. Rev. B* **88**, 115309 (2013).
  
10. **G. M. Vanacore**,  
Strain-induced work function changes in Ge nano-stripes on Si(001) studied by energy-filtered photoelectron  
emission microscopy,  
*Nuovo Cimento C* **35**, 49-58 (2012). (invited paper)
  
09. D. Chrastina\*, **G. M. Vanacore**\*, M. Zani, M. Bollani, S. Schöder, M. Burghammer, P. Boye, G. Isella, R. Sordan,  
and A. Tagliaferri, (\*authors contributed equally)  
Patterning-induced strain relief in single lithographic SiGe nanostructures studied by nanobeam x-ray  
diffraction,  
*Nanotechnology* **23**, 155702 (2012).
  
08. M. Bollani, D. Chrastina, V. Montuori, D. Terziotti, E. Bonera, **G. M. Vanacore**, A. Tagliaferri, R. Sordan, C.  
Spinella, G. Nicotra,  
Homogeneity of Ge-rich nanostructures as characterized by chemical etching and transmission electron  
microscopy,  
*Nanotechnology* **23**, 045302 (2012)



07. **G. M. Vanacore**, M. Zani, M. Bollani, D. Colombo, G. Isella, J. Osmond, R. Sordan, and A. Tagliaferri, Size evolution of ordered SiGe islands grown by surface thermal diffusion on pit-patterned Si(100) surface, *Nanoscale Res. Lett.* **5**, 1921 – 1925 (2010).
06. M. Bollani, E. Bonera, D. Chrastina, A. Fedorov, V. Montuori, A. Picco, A. Tagliaferri, **G. M. Vanacore** and R. Sordan, Ordered Arrays of SiGe Islands from Low-Energy PECVD, *Nanoscale Res. Lett.* **5**, 1917–1920 (2010).
05. **G. M. Vanacore**, M. Zani, G. Isella, J. Osmond, M. Bollani, and A. Tagliaferri, Quantitative investigation of the influence of carbon surfactant on Ge surface diffusion and island nucleation on Si(100), *Phys. Rev. B* **82**, 125456 (2010).
04. **G. M. Vanacore**, L. F. Zagonel, and N. Barrett, Surface enhanced covalency and Madelung potentials in Nb-doped SrTiO<sub>3</sub> (100), (110) and (111) single crystals, *Surf. Sci.* **604**, 1674-1683 (2010).
03. A. Pancotti, N. Barrett, L. F. Zagonel, and **G. M. Vanacore**, Multiple scattering X-Ray photoelectron diffraction study of the SrTiO<sub>3</sub>(100) surface, *J. Appl. Phys.* **106**, 034104 (2009).
02. A. Broglia, P. Pinacci, A. Radaelli, A. Bottino, G. Capannelli, A. Comite, **G. M. Vanacore**, M. Zani, Synthesis and characterization of Pd membranes on alumina-modified porous stainless steel supports, *Desalination* **245**, 508-515 (2009).
01. F. Ghezzi, M. Zani, S. Magni, **G. M. Vanacore**, A. Tagliaferri, Surface and bulk modification of W–La<sub>2</sub>O<sub>3</sub> armor mock-up, *J. Nucl. Mater.* **393**, 522–526 (2009).