IRENE VILLA

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SCIENTIFIC INTERESTS AND CURRENT POSITION

During my research career, **I have explored different topics of the solid-state Physics**, starting from archeometry, a branch of Physics mostly related to cultural heritage. During this period, I gained good experiences in thermoluminescence dating and also in more practical aspects, like archeological samples harvesting in chemical laboratory. Afterwards**, my research became focused on the study nd develpoment of advanced luminescent nanomaterials for application in photonics, scintillation, and biomedical technology. The goal of my research work is to tackle both fundamental and applicative aspects aimed at developing of real-world devices** and overcoming the drawbacks of the tools and technologies currently in use. The experimental activity is centered on continuos wave and time resolved photoluminescence and scintillation spectroscopy, confocal imaging and electronic microscopy.

My research activity has been supported by the several prestigious fellowships and it has been awarded in 2017 and 2021 as best paper and best communication, respectively. I have now concluded my work as Marie Curie Research Fellow at the Institute of Physics in Prague (CZ), focused on the development of new scintillating composite materials for fast timing detection.

I am author and co-author of 28 papers (12 as fist or corresponding author, 3 invited) published in international journals with average IF > 8, including several publications on high impact journals of the Nature family (1 as first author). Among them, 2 are contributions to peer-reviewed edited volume/monographs. To date, my work received 803 citations (Scopus) resulting a Hirsch factor of 13 (1030 citations, H-factor= 16 on Google Scholar).

From May 2022, **I achieved the National Scientific qualification as Associate Professor** in the Italian higher education system for the disciplinary field 02/B1- Experimental Physics of Matter (Ministerial Decree n° 553/2021 and 589/2021)

EDUCATION

- 07-09-2015 Ph.D. in Materials Science/European Doctorate on Physics and Chemistry of Advanced Materials, University of Milano – Bicocca, ITA
  Structural and morphological tuning of inorganic luminescent nanophosphors: Towards applications in sensing and lighting
- 07-10-2008 M. Sc. Degree in Physics 110/110 magna cum laude, University of Milano, ITA
  Studio di luminescenza termicamente e otticamente stimolata in vetro musivo antico
  (English: Study of thermally and optically stimulated luminescence in ancient glass mosaic)
- 28-02-2006 B. Sc. Degree in Physics 100/110, University of Milano, ITA
  Analisi XRF in ceramiche antiche (English: XRF analysis of ancient ceramics)

POSITIONS and FELLOWSHIPS

- 1/10/2020 – 30/09/22 MSCA Research Fellow (101003405- HANSOME - WF-02-2019)
  Institute of Physics AS CR, FZU, Prague, CZ
  HANSOME – Hafnium oxide based nanocomposite scintillators for fast timing detection
- 01/01/2020 – 30/09/2020 Research Fellow
  Dept. Materials Science University of Milano – Bicocca, ITA
  Radioluminescence and scintillation mechanisms in composite materials for the detection of ionizing radiation based on fluorescent metal-organic frameworks (MOF) nanocrystals
- 01/01/2016 – 31/12/2019 Research Fellow
  Dept. Materials Science University of Milano – Bicocca, ITA
  Scintillating Nano-oxides for Deep-Tissue Photodynamic Therapy
- 01/01/2015 – 31/12/2015 "Della Riccia" Research Fellow in Materials Science
  Universidad Autonoma de Madrid, ESP
  Fluorescence Thermal Bioimaging based on Nanoparticle
- 13/04/2013- 13/10/2013 Visiting PhD
  Universidad Autonoma de Madrid, ESP
- 01/01/2012 – 31/12/2014 PhD student
  Dept. Materials Science University of Milano – Bicocca, ITA
- 01/05/2009-31/12/2011 Junior Research Fellow
  Dept. Materials Science University of Milano – Bicocca, ITA
  Innovative archaeometric technologies for dating and characterization of archaeological materials)

AWARDS

Best Oral Presentation Award, **LumDeTr 2021 Conference**, from 30 years the most influential conference on radioluminescence.

2017 Top Papers Award - **Nano Research (IF 8.9)**, established as a recognition of paper impact in the previous two years.

COMMOSSION OF TRUST ACTIVITIES

From 2016, I serve a s reviewer for international scientific journals with peer-to-peer review: Optical Materials; Radiation Measurements; Dalton Transactions, MDPI Materials, MDPI Nanomaterials, MDPI Coatings, and Solid State Sciences.

MAJOR COLLABORATIONS

- Dr. A.- L. Bulin, Universitè Grenoble-Alpes, Grenoble, FRA.
  Metal oxide nanoscintillators for radiotherapy.
- Prof. M. Nikl, FZU Prague, CZ.
  Hafnium oxide nanocomposite scintillators for fast timing detection (MSCA-WF-HANSOME)
- Prof. Y. Torrente, Ospedale Maggiore-Policlinico in Milano.
  Luminescent nanomaterials for imaging and X-ray activated photodynamic therapy.
- Prof. C. Dujardin Université Claude Bernard Lyon, FRA. Prof. M. Nikl, FZU Prague, CZ.
  Dr. Edith Bourret–Courchesne, Berkely National Labs, Berkely, CA, USA.
  Development of fast scintillators based on QDs/perovskites, inorganic/hybrids materials (H2020 projects - ASCIMAT and INTELUM (RISE))

- Dr. A. Lauria, Prof. M. Niederberger, ETH Zürich, SUI.
  Metal oxides nanocrystals for photonics/scintillation applications.
- Prof. J. G. Solé, Prof. D. Jacque, Universidad Autónoma de Madrid, ESP.
  Novel bio-probes for cancer theranostics, high-resolution bioimaging, and intracellular sensing.

PERIODS ABROAD

- From October 2020 to September 2022 I worked under the MSCA-WF Project HANSOME (101003405) as research fellow at the Institute of Physics of the Czech Academy of Sciences (FZU), Prague, CZ.
- In the framework of the EU Research and Innovation H2020 programs, I worked as visiting researcher at the Lawrence Berkeley National Laboratory (1 month, in 2018) and at the Institute of Physics of the ASCR in Prague (2 weeks in 2016 and 2 weeks in 2018).
- In 2015 I won the Research Prize "Angelo Della Riccia" and I joined the Fluorescence Imaging Group (FIG) of the Universidad Autónoma de Madrid, Madrid (ESP) as research fellow, for 1 year.
- 2013. Visiting PhD, Universidad Autónoma de Madrid, Madrid,ESP.

SUPERVISION

Dept. Materials Science, University of Milano – Bicocca, ITA
2018 – one Master's thesis supervisor
2019 – one Bachelor's thesis supervisor
2018-2021 one PhD thesis tutor, Materials Science and Nanotechnology course

TEACHING

2008 to 2011- Laboratory assistant and tutor for PHYSICS LABORATORY (50 hours/year)
University Milano-Bicocca - Materials Science Master's Degree

2010/2011 - Lectures and laboratory tutoring for COMPLEMENTS OF PHYSICS 1(20 hours/year)
University Milano-Bicocca - Primary Education Master's Degree Course

2014 to 2019 - National Project LAUREE SCIENTIFICHE, high-school students laboratory (80 hours/year)
University Milano-Bicocca

PUBLICATIONS

1 - Crapanzano, R., **Villa, I**., Mostoni, S., D'Arienzo, M., Di Credico, B., Fasoli, M., Lorenzi, R., Scotti, R. and Vedda, A., 2022. Photo-and radio-luminescence of porphyrin functionalized ZnO/SiO 2 nanoparticles. (2022) *Physical Chemistry Chemical Physics*, 24, 21198-21209 DOI: 10.1039/D2CP00884J

2 - Perego, J., Bezuidenhout, C.X., **Villa, I**., Cova, F., Crapanzano, R., Frank, I., Pagano, F., Kratochwill, N., Auffray, E., Bracco, S., Vedda, A., Dujardin, C., Sozzani, P.E., Meinardi, F., Comotti, A., Monguzzi, A. Highly luminescent scintillating hetero-ligand MOF nanocrystals with engineered Stokes shift for photonic applications (2022) *Nature Communications*, 13 (1), art. no. 3504 DOI: 10.1038/s41467-022-31163-0

3 - [INVITED] Secchi, V., Monguzzi, A., **Villa, I**. Design Principles of Hybrid Nanomaterials for Radiotherapy Enhanced by Photodynamic Therapy (2022) *International Journal of Molecular Sciences*, 23 (15), art. no. 8736 DOI: 10.3390/ijms23158736

4 - Crapanzano, R**.**, **Villa, I**., Di Credico, B., D'Arienzo, M., Fasoli, M., Mostoni, S., Scotti, R., Vedda, A. Defect-Related Optical Properties of ZnO Nanoparticles in ZnO/SiO2 Systems (2022) *NATO Science for Peace and Security Series B: Physics and Biophysics*, pp. 255-257
DOI: 10.1007/978-94-024-2138-5_17

5 - [INVITED] **Villa, I**., Gonzalez, B.S., Orfano, M., Cova, F., Secchi, V., Colombo, C., Páterek, J., Kučerková, R., Babin, V., Mauri, M., Nikl, M., Monguzzi, A. The sensitization of scintillation in polymeric composites based on fluorescent nanocomplexes (2021) *Nanomaterials*, 11 (12), art. no. 3387 DOI: 10.3390/nano11123387

6 - [INVITED] Crapanzano, R., Secchi, V., **Villa, I.** Co-adjuvant nanoparticles for radiotherapy treatments of oncological diseases (2021) *Applied Sciences* (Switzerland), 11 (15), art. no. 7073
DOI: 10.3390/app11157073

7 - Perego, J. & **Villa, I**., Pedrini, A., Padovani, E.C., Crapanzano, R., Vedda, A., Dujardin, C., Bezuidenhout, C.X., Bracco, S., Sozzani, P.E., Comotti, A., Gironi, L., Beretta, M., Salomoni, M., Kratochwil, N., Gundacker, S., Auffray, E., Meinardi, F., Monguzzi, A. Composite fast scintillators based on high-Z fluorescent metal–organic framework nanocrystals (2021) *Nature Photonics*, 15 (5), pp. 393-400 DOI: 10.1038/s41566-021-00769-z

8 - **Villa, I.,** Villa, C., Crapanzano, R., Secchi, V., Tawfilas, M., Trombetta, E., Porretti, L., Brambilla, A., Campione, M., Torrente, Y., Vedda, A., Monguzzi, A. Functionalized Scintillating Nanotubes for Simultaneous Radio- And Photodynamic Therapy of Cancer (2021) *ACS Applied Materials and Interfaces*, 13 (11), pp. 12997-13008. DOI: 10.1021/acsami.1c02504

9 - Crapanzano, R., **Villa, I**., Mostoni, S., D'arienzo, M., Di Credico, B., Fasoli, M., Scotti, R., Vedda, A. Morphology related defectiveness in ZnO luminescence: From bulk to nano-size (2020) *Nanomaterials*, 10 (10), art. no. 1983, pp. 1-19. DOI: 10.3390/nano10101983

10 - Gandini, M., **Villa, I**., Beretta, M., Gotti, C., Imran, M., Carulli, F., Fantuzzi, E., Sassi, M., Zaffalon, M., Brofferio, C., Manna, L., Beverina, L., Vedda, A., Fasoli, M., Gironi, L., Brovelli, S. Efficient, fast and reabsorption-free perovskite nanocrystal-based sensitized plastic scintillators (2020) *Nature Nanotechnology*, 15 (6), pp. 462-468. DOI: 10.1038/s41565-020-0683-8

11 - **Villa, I.,** Moretti, F., Fasoli, M., Rossi, A., Hattendorf, B., Dujardin, C., Niederberger, M., Vedda, A., Lauria, A. The Bright X-Ray Stimulated Luminescence of HfO2 Nanocrystals Activated by Ti Ions (2020) *Advanced Optical Materials*, 8 (1), 1901348, DOI: 10.1002/adom.201901348.

12 - Zorloni, G., Cova, F., Caresana, M., Di Benedetto, M., Hostaša, J., Fasoli, M., **Villa, I**., Veronese, I., Fazzi, A., Vedda, A. Neutron/γ discrimination by an emission-based phoswich approach (2019) *Radiation Measurements*, 129, art. no. 106203 DOI: 10.1016/j.radmeas.2019.106203

13 - Buryi, M., Král, R., Babin, V., Páterek, J., Vaněček, V., Veverka, P., Kohoutková, M., Laguta, V., Fasoli, M., **Villa, I**., Cova, F., Vedda, A., Nikl, M. Trapping and Recombination Centers in Cesium Hafnium Chloride Single Crystals: EPR and TSL Study (2019) *Journal of Physical Chemistry C*, 123 (32), pp. 19402-19411. DOI: 10.1021/acs.jpcc.9b05760

14 - D'Arienzo, M., Mostoni, S., Crapanzano, R., Cepek, C., Di Credico, B., Fasoli, M., Polizzi, S., Vedda, A., **Villa, I**., Scotti, R. Insight into the Influence of ZnO Defectivity on the Catalytic Generation of Environmentally Persistent Free Radicals in ZnO/SiO2 Systems (2019) *Journal of Physical Chemistry C,* 123 (35), pp. 21651-21661. DOI: 10.1021/acs.jpcc.9b06900

15 - Beretta, M., Amirkhani, A., Brofferio, C., Brovelli, S., Buonanno, L., Cova, F., Capelli, S., Fasoli, M., Fiorini, C., Gironi, L., Vedda, A., **Villa, I**. The ESQUIRE project: Quantum Dots as scintillation detectors (2019) *Nuovo Cimento della Societa Italiana di Fisica C,* 42 (4), art. no. 191884 DOI: 10.1393/ncc/i2019-19188-4

16 - **Villa, I.,** Villa, C., Monguzzi, A., Babin, V., Tervoort, E., Nikl, M., Niederberger, M., Torrente, Y., Vedda, A., Lauria, A. Demonstration of cellular imaging by using luminescent and anti-cytotoxic europium-doped hafnia nanocrystals (2018) Nanoscale, 10 (17), pp. 7933-7940.
DOI: 10.1039/c8nr00724a

17 - **Villa, I.,** Lauria, A., Moretti, F., Fasoli, M., Dujardin, C., Niederberger, M., Vedda, A. Radio-luminescence spectral features and fast emission in hafnium dioxide nanocrystals (2018) *Physical Chemistry Chemical Physics*, 20 (23), pp. 15907-15915.
DOI: 10.1039/c8cp01230j

18 - Vedda, A., **Villa, I**. Medical applications of nanomaterials (2017) *NATO Science for Peace and Security Series B: Physics and Biophysics*, pp. 369-386. DOI: 10.1007/978-94-024-0850-8_18

19 - Del Rosal, B., **Villa, I**., Jaque, D., Sanz-Rodríguez, F. In vivo autofluorescence in the biological windows: the role of pigmentation (2016) *Journal of biophotonics*, 9 (10), pp. 1059-1067.
DOI: 10.1002/jbio.201500271

20 - **Villa, I.,** Vedda, A., Fasoli, M., Lorenzi, R., Kränzlin, N., Rechberger, F., Ilari, G., Primc, D., Hattendorf, B., Heiligtag, F.J., Niederberger, M., Lauria, A. Size-Dependent Luminescence in HfO2 Nanocrystals: Toward White Emission from Intrinsic Surface Defects (2016) *Chemistry of Materials*, 28 (10), pp. 3245-3253. DOI: 10.1021/acs.chemmater.5b03811

21 - **Villa, I.,** Vedda, A., Cantarelli, I.X., Pedroni, M., Piccinelli, F., Bettinelli, M., Speghini, A., Quintanilla, M., Vetrone, F., Rocha, U., Jacinto, C., Carrasco, E., Rodríguez, F.S., Juarranz, Á., del Rosal, B., Ortgies, D.H., Gonzalez, P.H., Solé, J.G., García, D.J. 1.3 μm emitting SrF2:Nd3+ nanoparticles for high contrast in vivo imaging in the second biological window (2015) *Nano Research*, 8 (2), pp. 649-665. DOI: 10.1007/s12274-014-0549-1

22 - Martini, M., Fasoli, M., **Villa, I**. Defect studies in quartz: Composite nature of the blue and UV emissions (2014) *Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms,* 327 (1), pp. 15-21. DOI: 10.1016/j.nimb.2013.09.048

23 - Rocha, U., Kumar, K.U., Jacinto, C., **Villa, I**., Sanz-Rodríguez, F., Del Carmen Iglesias De La Cruz, M., Juarranz, A., Carrasco, E., Van Veggel, F.C.J.M., Bovero, E., Solé, J.G., Jaque, D. Neodymium-doped LaF3 nanoparticles for fluorescence bioimaging in the second biological window (2014) *Small,* 10 (6), pp. 1141-1154. DOI: 10.1002/smll.201301716

24 - Lauria, A., **Villa, I**., Fasoli, M., Niederberger, M., Vedda, A. Multifunctional role of rare earth doping in optical materials: Nonaqueous sol-gel synthesis of stabilized cubic HfO2 luminescent nanoparticles (2013) *ACS Nano*, 7 (8), pp. 7041-7052. DOI: 10.1021/nn402357s

25 - Martini, M., Fasoli, M., **Villa, I**., Guibert, P. Radioluminescence of synthetic and natural quartz (2012) *Radiation Measurements*, 47 (9), pp. 846-850. DOI: 10.1016/j.radmeas.2012.01.008

26 - Martini, M., Fasoli, M., Galli, A., **Villa, I**., Guibert, P. Radioluminescence of synthetic quartz related to alkali ions (2012) *Journal of Luminescence*, 132 (4), pp. 1030-1036. DOI: 10.1016/j.jlumin.2011.11.031

27 - Galli, A., Martini, M., Sibilia, E., Vandini, M., **Villa, I**. Dating ancient mosaic glasses by luminescence: The case study of San Pietro in Vaticano (2011) *European Physical Journal Plus*, 126 (12), art. no. 121, pp. 1-12. DOI: 10.1140/epjp/i2011-11121-x

28 - Galli, A., Martini, M., Sibilia, E., **Villa, I**. Towards luminescence dating of mosaic glass (2010) *Mediterranean Archaeology and Archaeometry*, 10 (SPEC.ISSUE 4), pp. 77-82.

PRESENTATIONS and CONTRIBUTIONS

I presented my work at 33 international conferences/ workshops, 4 on invitation listed below.

1) *Scintillation properties of advanced nanocomposite materials*, 11th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation, LumDeTr (September 2021, Bydgoszcz, PL)

2) *The longstanding investigation on defects in solids and recent approaches in driving inorganic nanomaterials luminescence,* 20th International Conference on Defects in Insulating Materials - ICDIM 2020 (November 2020, online conference)

3) *Inorganic nanomaterials and doping strategies for future perspective in scintillation application and nanomedicine,* 18th International Workshop on Photoluminescence in Rare-earths PRE'19 (September 2019, Nice, FRA)

4) *Luminescent Materials for biomedical applications, Workshop Women in Sciences, Le scienze con la D maiuscola* (May 2019, Milan, ITA)