Perspective PRIN2022

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DIPARTIMENTO DI FISICA

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DIPARTIMENTO DI CHIMICA,
MATERIALI E INGEGNERIA CHIMICA
GIULIO NATTA

Prof. Luca Andena

Finanziato dall'Unione europea
NextGenerationEU

MUR
Ministero dell'Università e della Ricerca

POLIMI Research Unit

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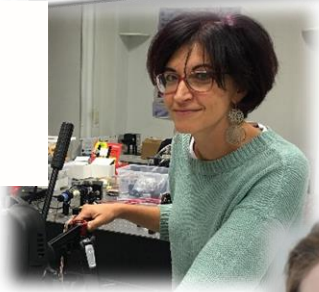
DIPARTIMENTO DI FISICA



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DIPARTIMENTO DI CHIMICA, MATERIALI E INGEGNERIA CHIMICA GIULIO NATTA

Prof. Luca ANDENA

POLYMER ENGINEERING PE LAB

PHOTONICS FOR HEALTH, FOOD AND CULTURAL HERITAGE

ArtIS
Imaging Spectroscopy for Cultural Heritage

Dr. Alessia CANDEO

e4SPORT Lab
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https://www.fisi.polimi.it/en/research-labs/artis--28

https://www.cmic.polimi.it/ricerca/elenco-gruppi-di-ricerca/polyenglab/

Unit objectives

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POLIMI research unit is responsible of WP5 and WP6 and participates to all WPs with particular relevance to WP4, WP5 and WP6.

In details:

- POLIMI will partecipate to WP4 aimed at the development of a non invasive multimodal approach to study the chemical composition of reference intact and aged plastic materials.

- POLIMI will coordinate WP5 through the study and optimization of conventional and innovative mechanical tests on reference intact and aged plastic materials.

- POLIMI will coordinate WP6 through the organization and coordination of 4 pilot case studies, where the developed NI multimodal approach will be tested to assess the material composition and mechanical/morphological properties of CH plastics and the real time monitoring of selected conservative interventions

Facilities

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✓ Time-resolved photoluminescence imaging and spectroscopy

✓ Hyperspectral imaging at different spatial scales (from large field of view to macro- and micro-imaging)

✓ Micro-scratch tester

Analytical imaging and spectroscopy tools to

- ✓ **assess the degradation status of plastic objects**
- ✓ **monitor the effectiveness of conservation treatments**
- ✓ **correlate surface chemical and mechanical properties with degradation**

Fluorescence spectroscopy and fluorescence lifetime imaging and spectroscopy will allow us to inspect photo-oxidative degradation at the surface of plastic reference materials and plastic objects

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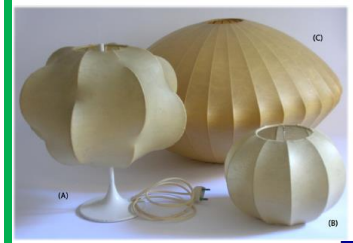
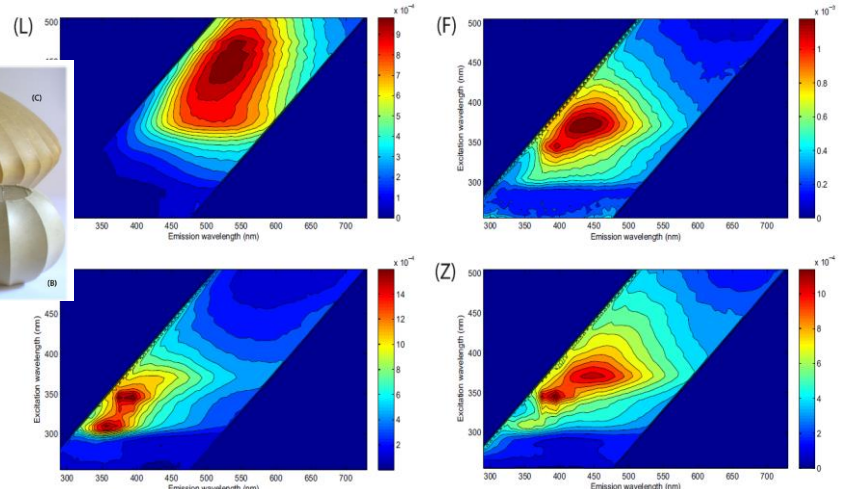
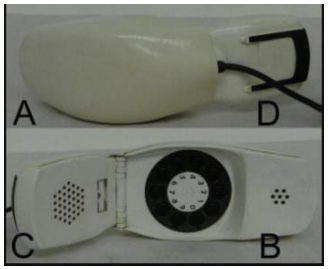




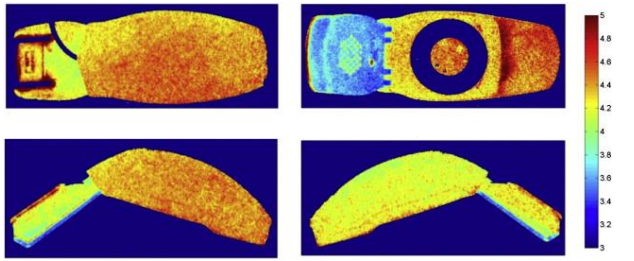
F. Toja, D. Saviello, A. Nevin, D. Comelli, M. Lazzari, G. Valentini, L. Toniolo (2013) "The degradation of poly(vinyl acetate) as a material for design objects: A multi-analytical study of the Cocoon lamps. Part 2". Polymer Degradation and Stability 98, 11: 2215-2223

Fluorescence excitation emission matrix, collected on analysis points of PVAc Cocoon lamps, demonstarte different degradation conditions



D. Comelli, F. Toja, C. D'Andrea, L. Toniolo, G. Valentini, M. Lazzari, A. Nevin (2014) "Advanced non-invasive fluorescence spectroscopy and imaging for mapping photo-oxidative degradation in acrylonitrileebutadienee styrene: A study of model samples and of an object from the 1960s ". Polymer Degradation and Stability 107: 356-365

Fluorescence lifetime maps of the surface of the ABS Grillo phone



Hyperspectral imaging at different spatial scales will allow us to inspect the correlation between chemical and mechanical changes at the surface of plastic reference materials and objects

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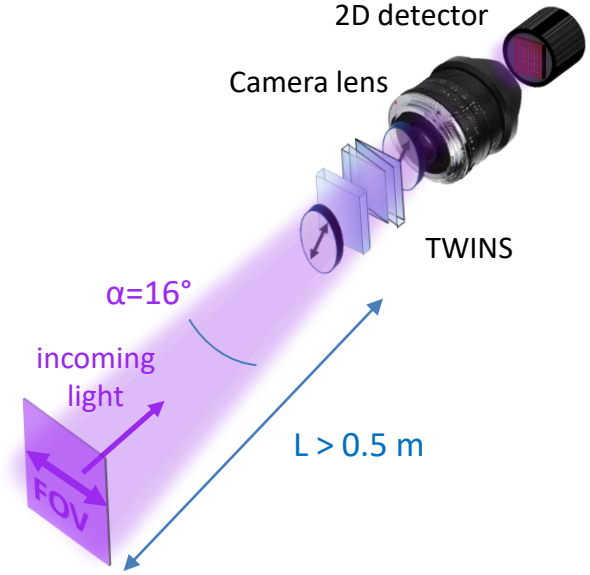
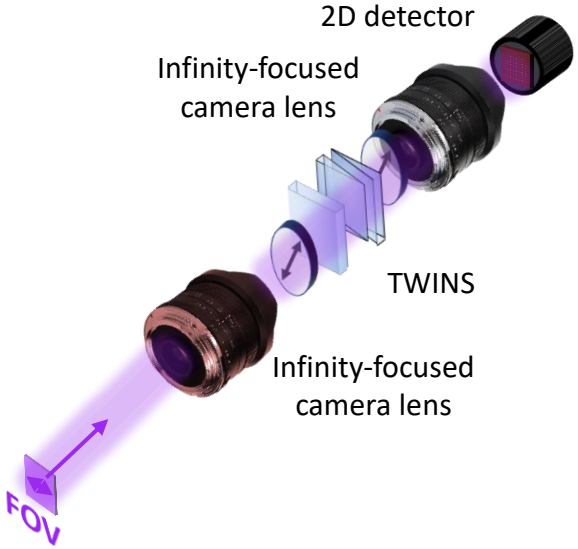
LARGE FIELD OF VIEW IMAGING



e.g. L = 1 m → **FOV ~ 30 cm x 30 cm**
L = 10 m → **FOV ~ 3 m x 3 m**

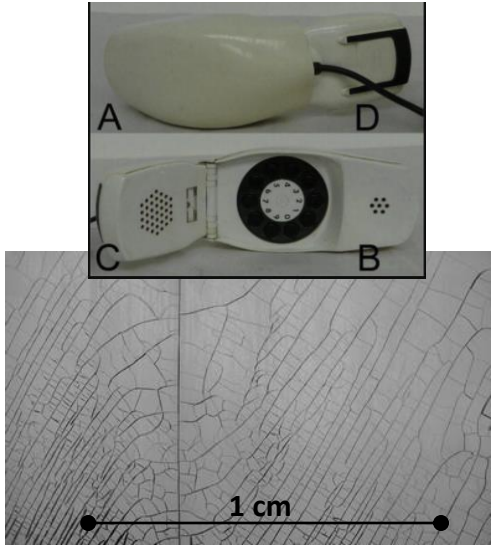
Spatial resolution ~ 0.3 – 3 mm

MACRO IMAGING



FOV ~ 1 cm x 1 cm

Spatial resolution ~ 10 µm



Microscratch testing can probe the surface mechanical properties of plastic reference materials and objects to assess their condition and monitor degradation phenomena

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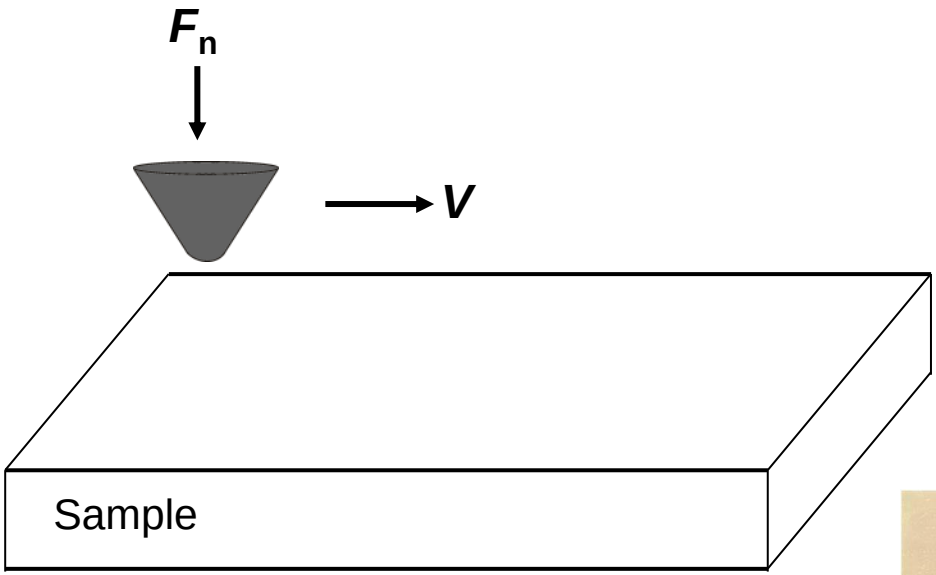

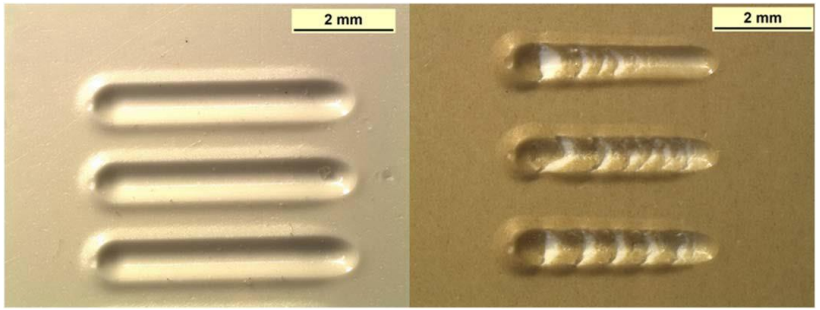

Set parameters

- ✓ F_n : Normal load
- ✓ V : Sliding tip velocity

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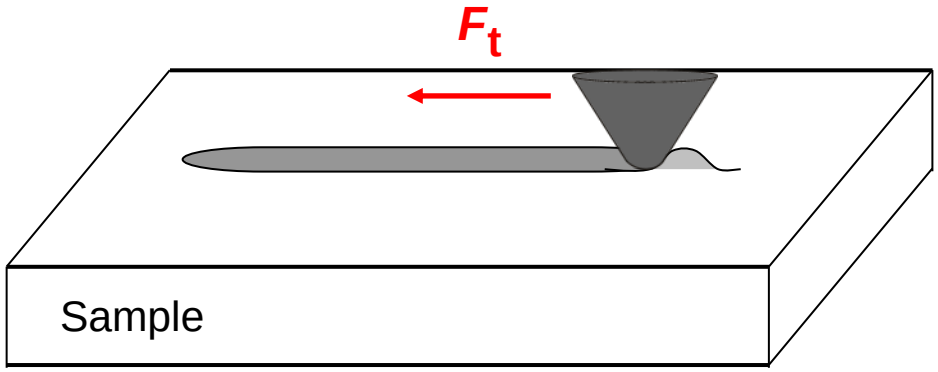

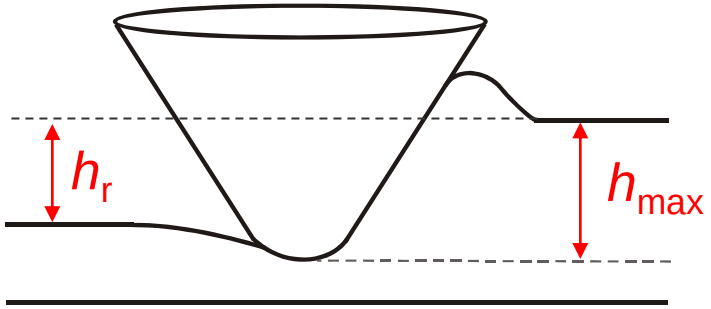

Measured quantities

- ✓ F_t : tangential force
- ✓ h_{max} : penetration depth
- ✓ h_r : residual depth
- ✓ acoustic emission

Publications

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- Ghirardello, M., Candeo, A., Ardini, B., ...Gironda, M., Comelli, D., *Time-resolved photoluminescence imaging for the mapping weakly luminescent pigments in paintings*, European Physical Journal Plus, 2023, 138(10), 906
- Candeo, A., Ardini, B., Ghirardello, M., ... Manzoni, C., and Comelli, D., *Performances of a portable Fourier transform hyperspectral imaging camera for rapid investigation of paintings*, European Physical Journal Plus, 2022, 137(3), 409
- Ghirardello, M., Manzoni, C., Gironda, M., ...Valentini, G., Comelli, D., *A novel photoluminescence hyperspectral camera for th study of artworks*, European Physical Journal Plus, 2021, 136(10), 1052
- Andena, L. , Tagliabue, S. , Pavan, A., Marenghi, A. , Testa, M., Frassine, R. *Probing athletics tracks degradation using a microscratch technique*, Polymer Testing 89 (2020) 106602
- Perri, A., de Faria, B.E.N., Teles Ferreira, D.C., ...Cerullo, G., Manzoni, C. *Hyperspectral imaging with a TWINS birefringent interferometer*, Optics Express, 2019, 27(11), pp. 15956–15967
- Tagliabue, S. , Andena, L. , Pavan, A. Marenghi, A. , Testa, M., Frassine, R. *Ageing in athletics tracks: A multi-technique experimental investigation*, Polymer Testing 69 (2018) 293-301
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- Toja, F., Saviello, D., Nevin, A., ...Levi, M., Toniolo, L., *The degradation of poly(vinyl acetate) as a material for design objects: A multi-analytical study of the effect of dibutyl phthalate plasticizer. Part 1,* Polymer Degr. and Stab., 2012, 97(11), pp. 2441–2448
- Toja, F., Nevin, A., Comelli, D., ...Cubeddu, R., Toniolo, L. *Fluorescence and Fourier-transform infrared spectroscopy for the analysis of iconic Italian design lamps made of polymeric materials*, Anal. and Bioanal. Chem., 2011, 399(9), pp. 2977–2986
- Nevin, A., Comelli, D., Valentini, G., Cubeddu, R., *Total synchronous fluorescence spectroscopy combined with multivariate analysis: Method for the classification of selected resins, oils, and protein-based media used in paintings,* Analytical Chemistry, 2009, 81(5), pp. 1784–1791

Previous Projects

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- **2020-2022** – ***CARLA - The European Photonics CAReer LAunch Path*** funded by the European Community under the H2020-ICT-2018-2020 call (contract number 871457) https://cordis.europa.eu/project/id/871457 - https://carlahub.eu/.
- **2019-2021** – ***MAPPing - Novel methods and devices for the chemical MApping of Paintings through Photoluminescence imaging*** funded by the Italo-French University within the Galileo 2019 call (project code: G19-74).
- **2015-2019** – ***LeadART - Induced decay and aging mechanisms in paintings: focus on interactions between lead and zinc white and organic material*** funded by MUR (formerly MIUR) as part of the JPI - JHEP JOINT PILOT TRANSNATIONAL CALL for Joint Research Projects on Cultural Heritage. https://www.era-learn.eu/network-information/networks/jpi-cultural-heritage/jpi-jhep-pilot-call
- **2015-2017** – ***La durabilità delle superfici per piste di atletica,***funded by MONDO SpA
- **2013-2016** – ***FUTURAHMA*** - ***From FUTurism to Classicism, Research, Art History and Material Analysis*** (MIUR Futuro in ricerca FIRB 2012).
- **2013-2015** – ***Objects and Materials of Egyptian Archaeological Heritage: Portable Spectroscopy and Imaging*****,** Bilateral Scientific and Technological Research Projects of Great Relevance funded by MAECI.