Seminar of Dr. Matteo GHIDELLI

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Mai 26, 2026 at 2.00 pm
IJL, Room 4.A014

Overcoming the Strength-Plasticity Trade-Off in Metallic Thin Films through Atomic and Microstructural Design Strategies

The current trend toward miniaturization in devices components in key technologies such as microelectronics, energy production, sensors and wear protection require the development of high-performance thin films (TFs) with superior mechanical properties combining mutually excluding mechanical properties such as high yield strength and plastic deformation. Achieving such performance, relies on leveraging TF's atomic composition and microstructure (nanointerfaces, grain size etc.) exploiting nanoengineering design concepts. Here, I will present recent results for several class of advanced TF materials including nanostructured **metallic glasses** (ZrCu, ZrCuAl) [1] **high entropy alloys** (CoCuCrFeNi, Al_xCoCuCrFeNi) [2] and **nanolaminates** (fully amorphous, amorphous/crystalline, FCC/BCC) [3, 4], highlighting how the control of the microstructure affects the and micro-scale mechanical behavior and enable ultimate overcoming the strength-plasticity paradigm. Among the main results, I will show the **fabrication of fully amorphous $Zr_{24}Cu_{76}$/$Zr_{61}Cu_{39}$** nanolaminates with controlled nanoscale periodicity (Λ, down to 5 nm), local chemistry and glass-glass interfaces, mitigating the shear band instability when $\Lambda \leq 50$ nm, reaching remarkably large elastic/plastic deformation (16%) and yield strength (~2GPa) by micro-pillar compression [3]. Then, I will present the synthesis **nanostructured metallic glass and High Entropy Alloy TFs**. I will show how **nanogranular** ZrCu metallic glass can reach ultimate yield strength (>3 GPa) and ductility (>6 %) [1]. Then, I will focus on the synthesis of crystal/glass **ultrafine nanolaminates** [4] in which ~4 nm Al (crystalline) separate 6 and 9 nm-thick $Zr_{50}Cu_{50}$ metallic glass nanolayers, showing high yield strength (3.4 GPa) in combination with enhanced elastoplastic deformation (>6%, in compression), while managing to effectively block the percolation of shear bands even at >15% deformation [4]. Finally, I will present, **a totally new nanoengineer concept for the synthesis of CoCrCuFeNi High Entropy Alloys** TFs with nanosized grains, enabling strong Hall-Petch strengthening, plastic deformably and thermal stability, reinventing traditional Cantor alloys and outperforming most advanced alloys [2].

[1] F. Bignoli, .., **M. Ghidelli**, Acta Materialia, 300, 121456, (2025).
[2] D. Vacirca, ..., **M. Ghidelli**, Materials Today, 95, 103280 (2026).
[3] A. Brognara, ..., **M. Ghidelli**, Small Structures, 2400011, 1-11, (2024).
[4] F. Bignoli, …, **M. Ghidelli**, ACS Applied Materials & Interfaces, 16, 27, 35686–35696 (2024).

Dr. Matteo Ghidelli is a permanent CNRS researcher at the Laboratoire des Sciences des Procédés et des Matériaux (LSPM-CNRS) and, since January 2025, **leads the research group "Mechanics of Functional Thin Films,"** comprising 7 faculty members and 15 researchers and engineers. He obtained a joint PhD in 2015 from Université Grenoble Alpes (France) and Université catholique de Louvain (Belgium) within the International Doctoral School in Functional Materials (IDS-FunMat). After postdoctoral positions in Italy and a group leader position at the Max Planck Institute for Sustainable Materials (Germany), where he led the "*Thin Films & Nanostructured Materials*" group, he joined LSPM in 2020. **His research focuses on the synthesis of nanostructured thin films and their micromechanical characterization**, with a particular emphasis on in situ SEM techniques. He develops advanced nanoengineering strategies – such as nanocomposites, nanogranular films, and interface-dominated materials – to tailor mechanical properties and deformation mechanisms at the microscale. His work contributes to the design of high-performance materials for demanding applications, including extreme environments. Dr. Ghidelli has authored more than 50 peer-reviewed publications (h-index 24, Scopus) and has secured >2M€ in competitive funding since 2020 from national, European, and industrial programs. He obtained his Habilitation à diriger des recherches (HDR) in 2022 and currently supervises 5 PhD students and 1 postdoc.

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