POLITECNICO DI MILANO

PhD in FISICA / PHYSICS - 40th cycle

PNRR 630 Research Field: ULTRABROADBAND SPECTROSCOPY

Monthly net income of PhDscholarship (max 36 months)
€ 1300.0 In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	Spectroscopy is the study of how matter interacts with electromagnetic radiation, providing insights into the composition and properties of substances. It's crucial for research and industry because it enables precise identification and analysis of materials, aiding in fields like chemistry, physics, and environmental science. With respect to other spectroscopic methods based on dispersive techniques, in this project the candidate will employ the Fourier-transform approach. It offers advantages such as higher resolution and improved signal-to-noise ratio, making it ideal for detailed spectral analysis. On top of that, Fourier-Transform spectroscopy is based on the use of a single-pixel detector that allows for an easy integration of multiple sensors covering different spectral ranges. In this way, it is possible to cover an ultrabroadband range within a single measurement. More specifically, in this project, the region from 400 nm to 4500 nm will be explored. Such a broad range offers a unique capability in combining color information in the visible with a chemical composition in the infrared range, enabling for an in-depth characterization of samples in e.g. textile industry, plastic sorting, geology, oil, wine and dairy industry. In this project, these and similar applications will be explored, in different geometry configurations such as absorbance, transmittance and diffuse reflectance.
Methods and techniques that will be developed and used to carry out the research	The candidate will employ a novel approach to Fourier-Transform spectroscopy, based on a patented ultra-stable common-path interferometer, completely insensitive to external vibrations. Unlike a Michelson or a

	external vibrations. Unlike a Michelson or a Mach–Zehnder interferometers, this device does not separate the two replicas in space (which would cause mechanical instabilities) but in polarization. To this purpose, it makes use of birefringence. In this class of materials, vertically and horizontally polarized light experience a different index of refraction, and thus it propagates with different speed. It is possible to vary the delay between the two replicas by changing the insertion of a birefringent wedge, thus continuously varying the material thickness. In this way, it is possible to obtain an extremely high delay stability and reproducibility (better than 1 attosecond, i.e. approx. a thousandth of the wavelength). For this reason, it can be used without any active control or position tracking even in harsh environments such as industries in the presence of vibrations.This instrument is already available as a commercial product at NIREOS: see TRICLOPS spectrometer (https://www.nireos.com/triclops/)The candidate will learn how to align the system, use the software and perform absorbance, transmittance and diffuse reflectance measurements in a large set of samples for commercial applications.
Educational objectives	The candidate will gain specific skills in the design of an ultra-broadband spectrometer based on a birefringent interferometer for Fourier-transform spectroscopy, its mechanical and optical design, software for instrument control and data analysis, as well as its application in various fields of practical commercial interest.
Job opportunities	The skills acquired during this research project will give the opportunity of a career in industrial companies oriented to the R&D in photonics, spectroscopy, materials science, biology, mining, food control and industrial quality control.
Composition of the research group	1 Full Professors 2 Associated Professors 2 Assistant Professors 5 PhD Students
Name of the research directors	Ptof. Dario Polli

Contacts
Email: dario.polli@polimi.it *Webpage:http://polli.faculty.polimi.it* *Tel number: 02.23.99.60.86*

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	650.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	NIREOS SRL Via G. Durando 39 20158 Milano (Italy) www.nireos.com
By number of months at the company	18
Institution or company where the candidate will spend the period abroad (name and brief description)	ICFO - SPAIN
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

***Educational activities*:¿** Educational activities (purchase of study books and material, funding for participation to courses, summer schools, workshops and conferences). Financial aid per PhD student per 3 years: max 5.300,25 euros per student.

***Teaching assistantship*:**There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

Computer availability: *shared use*
Desk availability*: shared use*

Other information: *See www.vibra.polimi.it*