POLITECNICO DI MILANO

PhD in FISICA / PHYSICS - 38th cycle

PNRR_352 Research Field: VISIBLE/INFRARED DETECTION BASED ON SILICON-GERMANIUM OPTOELECTRONIC DEVICES

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	The objective of this research project is the development of a cost-effective dual band imaging sensor operating in the visible (VIS) and short-wave infrared (SWIR) spectral ranges. The ability selectively address these two spectral bands will open exciting perspectives in many technological field including automotive, defense and security and environmental protection. In particular, one of the main objective of this research is to assess the possibility to use such sensor for the early detection of wildfires. The reduction of the risk of wildfires is an immediate priority of the PNRR (Missione 2: Rivoluzione verde e transizione ecologica, in particular ¿Tutela del territorio e della risorsa idrica¿) as well as of The Green Deal [https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_it]. Large-scale and more intense wildfires are becoming an increasing concern and they are considered of primary importance for the climate change. The sensor will be capable of detect low temperature (800 K) flames and to avoid sunlight interference. The imager will be based on an innovative Ge/Si double diode structure and it will be combined with a custom read-out integrated electronic circuit. A demonstration of early detection of wildfires will be carried out by the developed prototype. In a mid-term vision, a network of cost-effective sensors could be scattered throughout regions of concerns. If a wildfire ignites, the device deployed in the area will detect it and notify the nearby firefighting department.
Methods and techniques that will be	

developed and used to carry out the research	The development of the wildfire detection system prototype will require: • Epitaxial deposition of Ge and Si layers. • Micro-fabrication (laser lithography, plasma etching, e-beam metallization) of single pixels and of arrays of pixels. • Electrical and optical characterization of the processed devices (I-V curves, C-V curves, specific contact resistance measurements (TLM), photocurrent spectroscopy, single pixel imaging). • Software development to determine the temperature of the flames from the imaging data. The research work will be carried out at the L-NESS laboratory and at Polifab, the cleanroom of Politecnico di Milano, in collaboration with the start-up EYE4NIR s.r.l.
Educational objectives	The PhD Course [http://www.dottorato.polimi.it/] is characterized by a strong experimental character. It aims at providing high scientific education and training to develop general research abilities in all areas of applied physics. For this research project, the student will acquire an expertise in semiconductor epitaxial growth and device fabrication and characterization.
Job opportunities	The PhD student will acquire key competences in the fields of material science and micro/fabrication. Such competences will open job opportunities such as i) researcher in companies, universities, research centres or process engineer in semiconductor industries. At the end of the PhD program there will be also the possibility to be hired by the partner start-up EYE4NIR.
Composition of the research group	1 Full Professors 1 Associated Professors 1 Assistant Professors 3 PhD Students
Name of the research directors	Daniel Chrastina, Franco Ciccacci

Contacts
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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)	EYE4NIR (https://www.eye4nir.com/) is a spin-off of Politecnico di Milano
By number of months at the company	12
Institution or company where the candidate will spend the period abroad (name and brief description)	The foreign partner will a technology transfer center with the capabilities to realize an industrial prototype of the imager.
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: individual use

Desk availability: shared use

Other Information about Industrial Partner:

EYE4NIR (https://www.eye4nir.com/) is a spin-off of Politecnico di Milano and its objective is the commercialization of the Ge/Si double diode technology for several applications, including environmental protection, automotive and industrial automation. EYE4NIR has been recognized as one of the most interesting deep-tech startup in the Italian landscape and won several awards and grants, in particular: "Switch-to-Product 2019", a competition for deep-tech business ideas organized by the Politecnico di Milano and Deloitte; "StartCup Lombardia" in the Industrial Category; "National Innovation Prize" in the Industrial Category. EYE4NIR has recently received a seed investment (600 ke) from two Venture Capitals to support the industrial prototyping.