



PhD in INGEGNERIA DEI MATERIALI / MATERIALS ENGINEERING - 39th cycle

**PNRR 118 INTERDISC Research Field: DEVELOPMENT OF BIODEGRADABLE SENSORS
AND ACTUATORS VIA SUSTAINABLE ADDITIVE MANUFACTURING**

Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

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**

With the development of the internet of things, the need to develop sensors and actuators with the most varied characteristics at a low cost is increasingly present. Furthermore, the increasing attention to the planet and to pollution leads to a constant request for monitoring systems with low environmental impact. To answer this dual request, we propose the design, 3D printing manufacturing and testing of biodegradable sensors and actuators. The high flexibility and versatility of additive manufacturing techniques allows for the creation of highly customizable sensors and actuators on the base of their application. These can be used for monitoring buildings, structures at sea, agricultural land or even in the world of biomedical robotics. The project aims at introducing sustainable and efficient, from the use of resources point of view, production methodologies in the manufacturing of smart sensors/actuators. It therefore contributes to target 9.4 of SDG 9. With its intrinsically innovative value, it also contributes to target 9.5 of SDG 9. In the context of PNRR, the research can be framed within the action M1C2: digitalization, innovation and competitiveness in production systems. Particularly regarding the Transition 4.0, the need of new sensors with advanced capabilities and produced with new manufacturing techniques is part of the future development needed. The research will also allow the introduction of new manufacturing technologies, e.g. 3d or jet printing, into more traditional production lines so to foster the innovation and the technological



	modernization of companies in the field.
Methods and techniques that will be developed and used to carry out the research	The design, construction and experimental validation of sensors and actuators presents an intrinsic interdisciplinarity. A sensor/actuator, in order to function correctly, needs a mechanical part and an active part. The design of the mechanical part requires a solid knowledge of the mechanics of solids and structures in the linear and non-linear fields. The design of the active part for detection, on the other hand, requires a solid knowledge of materials and their dynamic behavior even in the presence of variable environmental conditions (temperature, humidity). Fabricating the device requires extensive expertise in polymer chemistry, additive manufacturing, and thin-film deposition techniques. Finally, the experimental validation requires a knowledge of electronics and circuit elements.
Educational objectives	The educational aims are: (1) amplify supported PhD research experience and favour co-operative research experience at possible partners; (2) elevate the educational experience by creating a highly visible centre for advanced sensors manufacturing.
Job opportunities	The introduction of new materials, processes and devices in sensors technology will implement the number of applications of these devices. Job opportunities for an expert PhD in this field are expected in the private and academic sector.
Composition of the research group	1 Full Professors 2 Associated Professors 2 Assistant Professors 8 PhD Students
Name of the research directors	Prof. Roberto Bernasconi - Prof.ssa Valentina Zega

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	700.0 €
By number of months	6

National Operational Program for Research and Innovation

Company where the candidate will attend the stage (name and brief description)	
By number of months at the company	0
Institution or company where the candidate will spend the period abroad (name and brief description)	da definire
By number of months abroad	6

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

Individual budget for research (5.700 euro): 1st year: 1.900 euro; 2nd year: 1.900 euro; 3rd year: 1.900 euro

Teaching assistantship (availability of funding in recognition of supporting teaching activities by the PhD student): there are various forms of financial 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 regulation.