MATERIALS SCIENCE AND TECHNOLOGY

IIT - 3D printing enabling morphological tactile sensing and mechanical interaction at different scales

Funded By	FONDAZIONE ISTITUTO ITALIANO DI TECNOLOGIA [P.iva/CF:09198791007]
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Context of the research activity	Fabrication of novel tactile sensors employing two photon polymerization technology (2PP), developing new materials and exploring bioinspired design of the structures.
Objectives	Micro- and nanostructured designs are playing an increasingly critical role in advancing tactile sensing technologies. These structures allow mechanical filtering of tactile stimuli (such as pressure, strain, or shear) directly through their geometry, reducing the complexity of signal processing and enhancing sensitivity [1,2]. Today it is possible to explore totally new designs at different scales owing to the strong advancements of 3D printing. However, the use of two-photon polymerization for tactile sensors is relatively unexplored. This microfabrication technology allows fabricating submicrometric objects and patterns that can be used for investigating new sensors, also with bioinspired morphology (e.g., hairs, wrinkles). Different materials and transduction mechanisms, such as optical and resistive, can be explored. The main challenges consist of printing specific soft materials (conductive and non-conductive), fabrication and testing of sensing design with nano-sized features. The main research objectives of this PhD thesis include: o Design of new sensors with typical bioinspired structures (e.g. hair-like, wrinkled/ridged skin-like) based on a specific transduction method (e.g. optical, resistive) o Investigation and fabrication of small-scale structures with (i) electrically conductive materials via direct or indirect approach (e.g., metal deposition, adsorption of conductive fillers) [3] and (ii) optically transparent materials. o Characterization and optimization of the tactile sensing devices at the microscale. The experimental activity will take place in collaboration with theSBRP lab of Istituto Italiano di Tecnologia of Genova. References: [1] Yu, H., Guo, H., Wang, J., Zhao, T., Zou, W., Zhou, P., Xu, Z., Zhang, Y.,

	Zheng, J., Zhong, Y. and Wang, X., 2024. Skin-Inspired Capacitive Flexible Tactile Sensor with an Asymmetric Structure for Detecting Directional Shear Forces. Advanced Science, 11(6), p.2305883. [2] Xu, K., Tang, Y., Liang, J., Zhao, T. and Guo, H., 2024. Flexible capacitive pressure sensor sensitized by tilted micropillar structures fabricated by two-photon polymerization. Journal of Materials Science: Materials in Electronics, 35(23), p.1579. [3] Bernardeschi, I., Ilyas, M. and Beccai, L., 2021. A review on active 3D microstructures via direct laser lithography. Advanced Intelligent Systems, 3(9), p.2100051.

Skills and competencies for the development of the activity	Candidates should have a solid nanotechnology and materials background and strong motivation to learn through advanced research. Expertise in 3D printing fabrication technologies, and materials and sensing characterization is preferred. Problem solving ability and practical experience for laboratory activity is mandatory.