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Department of Industrial and Information
Engineering and Economy (DIIIE)



3D printing and complex morphologies

SPEAKER

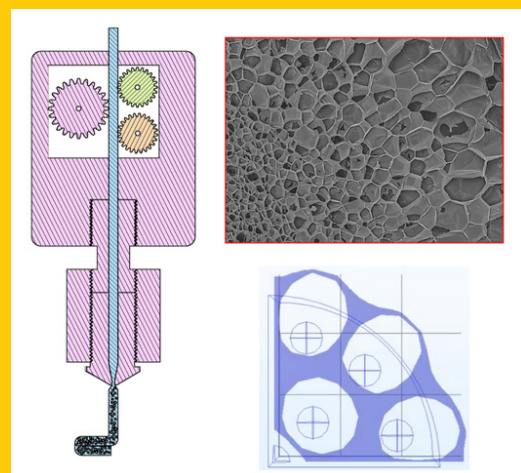
Prof. Pier Luca Maffettone

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ABSTRACT

An innovative process that merges additive manufacturing and physical foaming techniques creates intricate foam structures. In this process, a sustainable blowing agent (CO_2) is dissolved into a bio-polymer (PLA), which is then 3D-printed through a cylindrical nozzle. At the nozzle's exit, the blowing agent expands within the polymeric strand due to a drop in pressure and/or an increase in temperature. Our experiments reveal that by manipulating the temperature gradient at high printing speeds - corresponding to Graetz numbers exceeding one - the resulting microfoamed strands exhibit a unique microstructure characterized by anisotropic bubbles oriented in two distinct directions. Specifically, bubbles at the core of the strands stretch along the extrusion direction, while those at the periphery stretch radially. This dual orientation of micro-bubbles across the cross-section is unprecedented in foam morphology literature. To understand the mechanism behind this morphology, we conducted simplified modeling studies. The simulation outcomes corroborate our experimental observations and shed light on how the Graetz number influences both the microfoamed strand and the expansion of gas bubbles within a Newtonian fluid. Our numerical findings suggest that the varied bubble orientations result from the interplay between a high Graetz number and the radial expansion of the strand.



ABOUT THE SPEAKER

Pier Luca Maffettone, PhD, is Full Professor in Chemical Engineering at University of Naples "Federico II" where he was [2013-18] Chairman of the Department of Chemical-Materials-and-Production Engineering and is [2020-] Member of the University Board. He graduated in 1988 in Chemical Engineering under the supervision of Prof. G. Marrucci, and received the Ph.D. in Chemical Engineering at the University of Naples "Federico II" in 1993 under the supervision of Prof. G. Astarita. Pier Luca Maffettone became Assistant Professor in Chemical Engineering at the University of Naples "Federico II" in 1994. In 1998 he became Associate Professor of Chemical Engineering at Politecnico di Torino, and then became Full Professor of Chemical Engineering at the University of Naples "Federico II" in 2005. He was visiting scientist at the University of Delaware, at Katholieke Universiteit Leuven, at the Stanford University, and at Okinawa Institute of Science and Technology. His main research activity is focused on modeling and simulation of the flow behavior of soft matter. He is presently member of the Editorial Boards of Rheologica Acta and Journal Non-Newtonian Fluid Mechanics. He is 2023 recipient of the Weissenberg award bestowed by the European Society of Rheology.

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