# Soft active particles - from synthetic cells to a tissue

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**Résumé**

At microscopic scales, living organisms such as cells or bacteria exhibit both deformability and self-propulsion. At macroscopic scales, collective behaviors of organisms, such as schools of fish or herds of sheep, can also be modeled as self-propelled, deformable entities. To explore the interplay of activity and deformability, we design synthetic soft cells by encapsulating a miniature programmable robot (the GRASPion (1)) inside a soft elastic annular shell. The robot is programmed to behave as a Brownian particle with tunable properties thus rendering the whole cell motile. Firstly, we investigate the shape dynamics and statistics of a single moving free cell, describing its transport properties through experiments and numerical simulation. The cell is then confined within a canal of a ratcheted shape where we successfully demonstrate motion rectification and how it is affected by the cell rigidity and size, with these results being compared to numerical simulation. Finally, when densely packing a large number of cells in the plane, they begin to mimic the behavior of tissues, exhibiting transitions between fluid-like and solid-like states, as well as collective motion. Through experiments and simulations, we investigate the mechanical and dynamical properties of these synthetic tissues, revealing fluid-to-solid transitions driven by compression. These findings provide new insights into the principles governing active matter and its potential applications in tissue engineering and soft robotics. (1) F. Novkoski, M. Mélard, M. Delens, F. Wéry, M. Noirhomme, J. Pande, A. Maier, A.-S. Smith, N. Vandewalle; GRASPion: An open-source, programmable brainbot for active matter research. *Rev. Sci. Instrum.* 1 January 2026; 97 (1): 014704

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