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Mimicking the dynamics of the cell microenvironment via electromechanically active and microporous polyHIPE-PEDOT scaffolds

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Mimicking the dynamics of the cell microenvironment via electromechanically active and microporous polyHIPE-PEDOT scaffolds

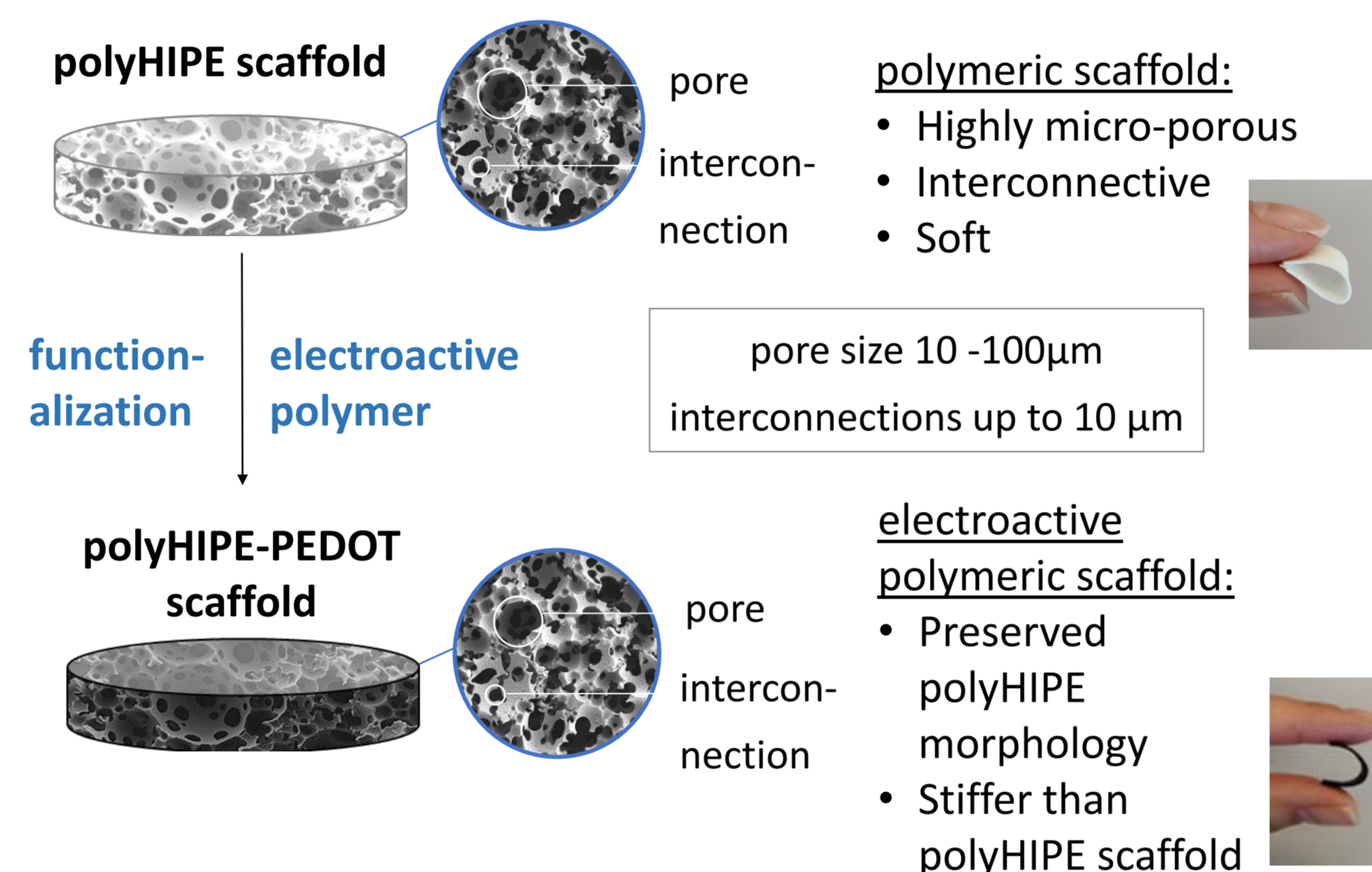
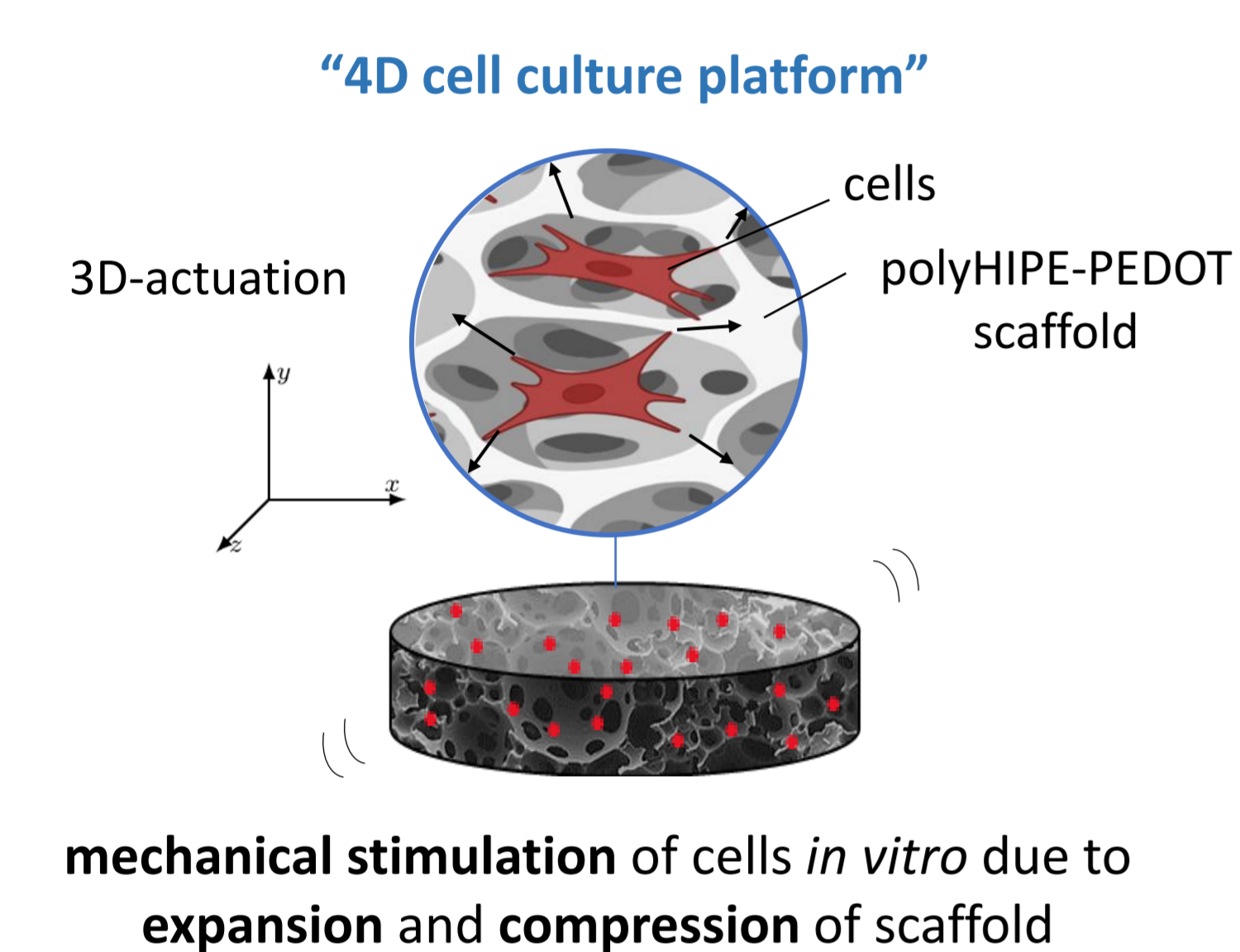
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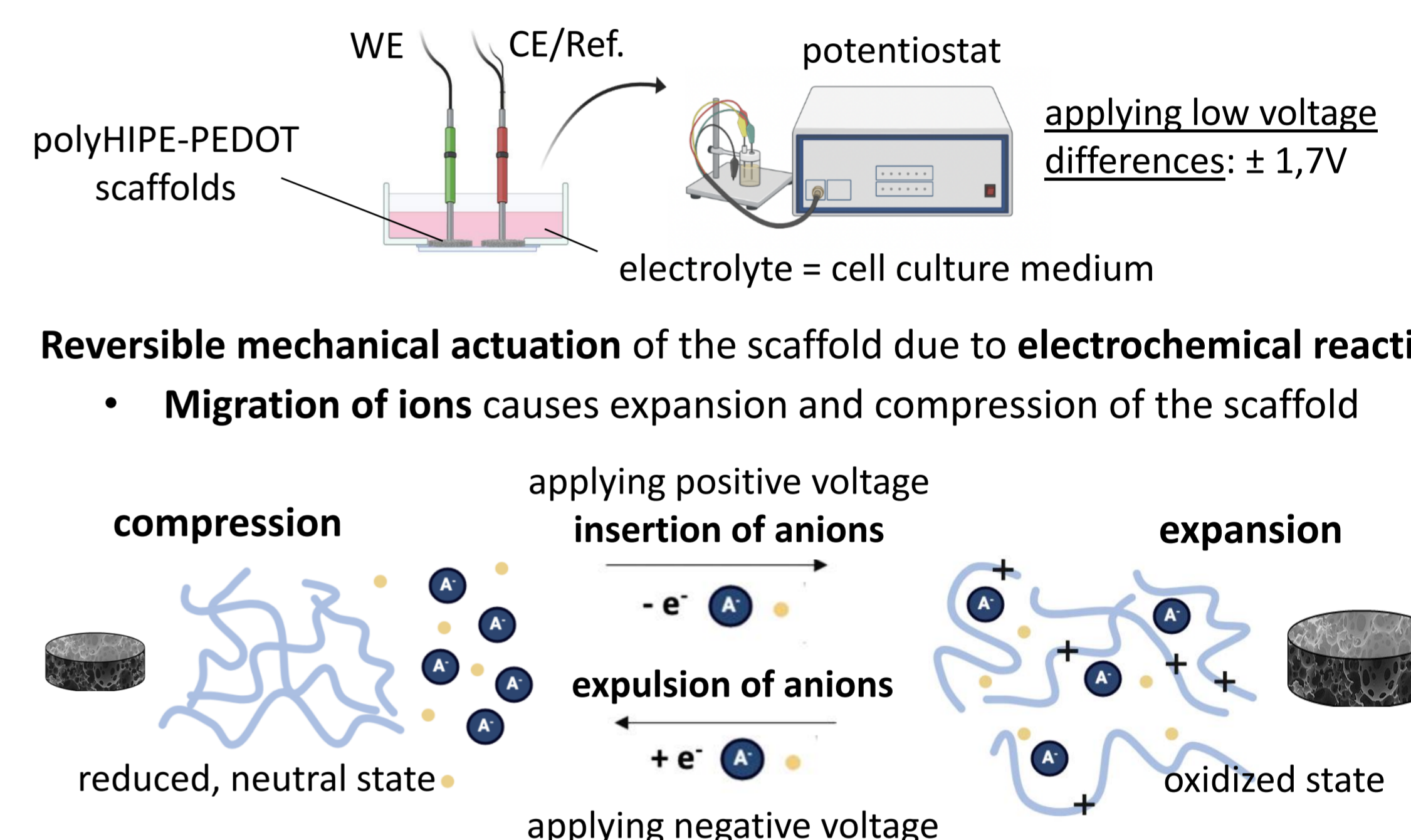
Abstract

In vivo, cells are surrounded by an extracellular matrix (ECM). Signals from the ECM such as biochemical or biophysical cues regulate cell behavior significantly. Although, 3D cell cultures offer biologically superior structures, there is still a lack in the transmission of dynamic mechanical signals that exist in the microenvironment of cells *in vivo*. The aim of this work is to develop a 4D microporous and electroactive scaffold as an innovative cell culture platform that enables the *in situ* electromechanical stimulation of cells and monitoring of the cell behavior. For this purpose, a 3D microporous scaffold is obtained from the polymerization of a high internal phase emulsion template. This so called polyHIPE is characterized by a high interconnectivity and a suitable porosity for a rapid cell colonization. In a further step the polyHIPE-scaffold is functionalized with a conducting polymer, the poly(3,4-ethylenedioxythiophene) (PEDOT). The functionalization leads to a 4D electroactive polyHIPE-PEDOT scaffold with stimuli-responsive properties such as changes in shape, morphology and pore size under external stimulation. Our results show that the stimulation process is reversible, stable and generates volume variations up to 10% on the scaffolds. Furthermore, the polyHIPE-PEDOT scaffolds support cell adhesion, spreading, migration and the cell viability is not affected by 5h of electromechanical stimulation.

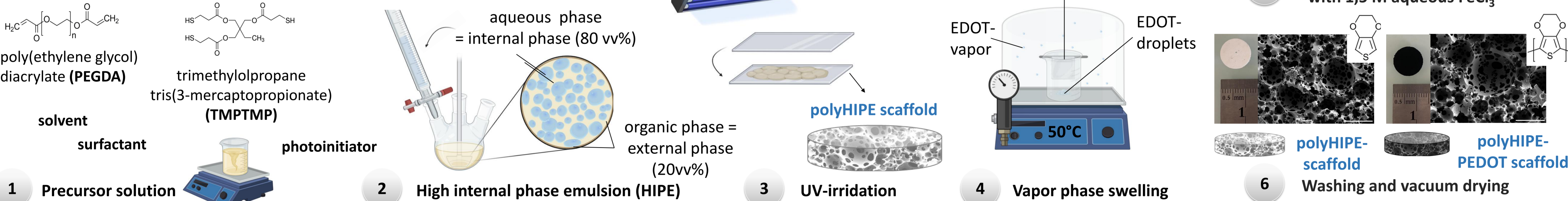
Main objective



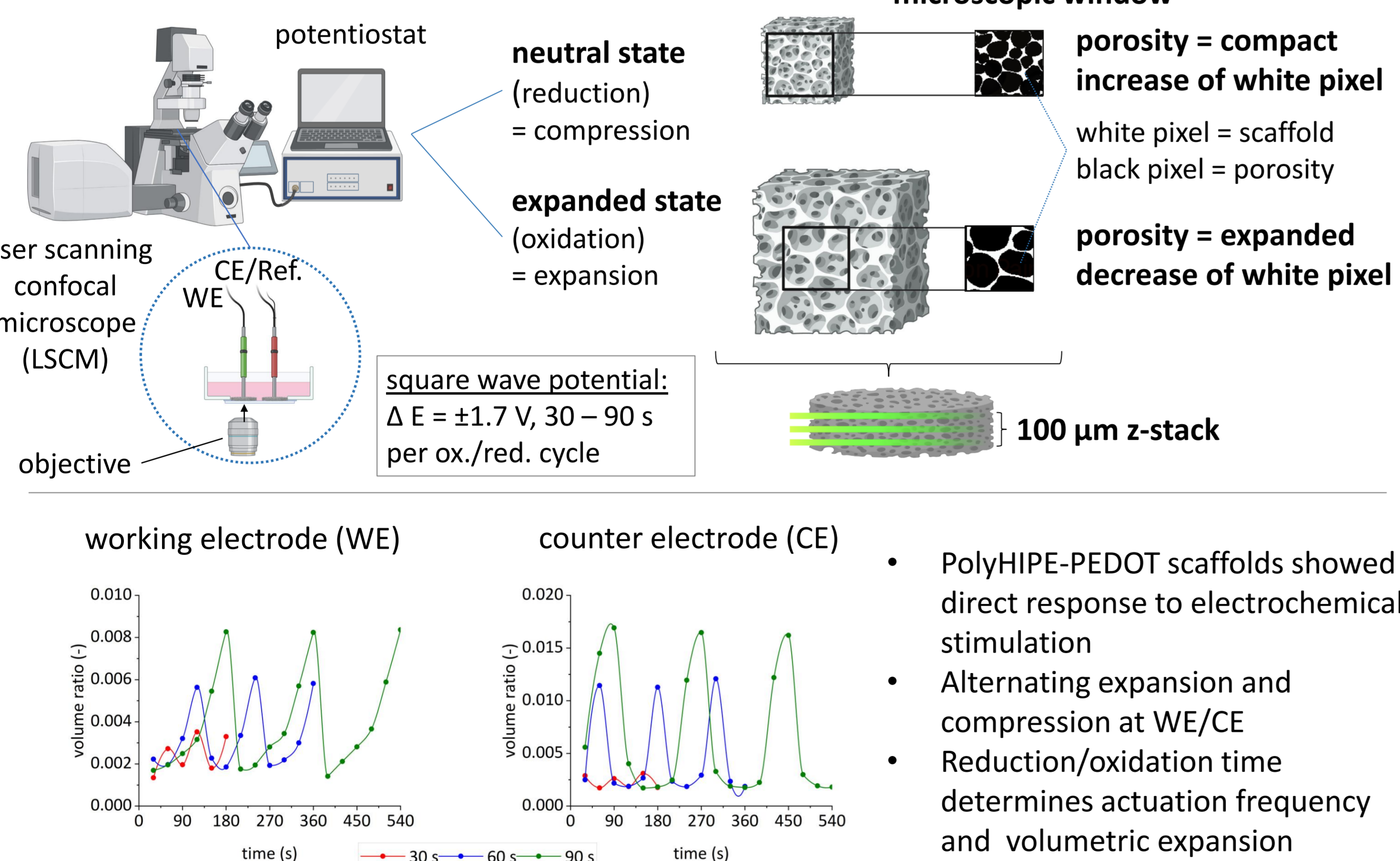
Electrochemical stimulation of the polyHIPE-PEDOT scaffolds



Synthesis of polyHIPE-PEDOT scaffolds

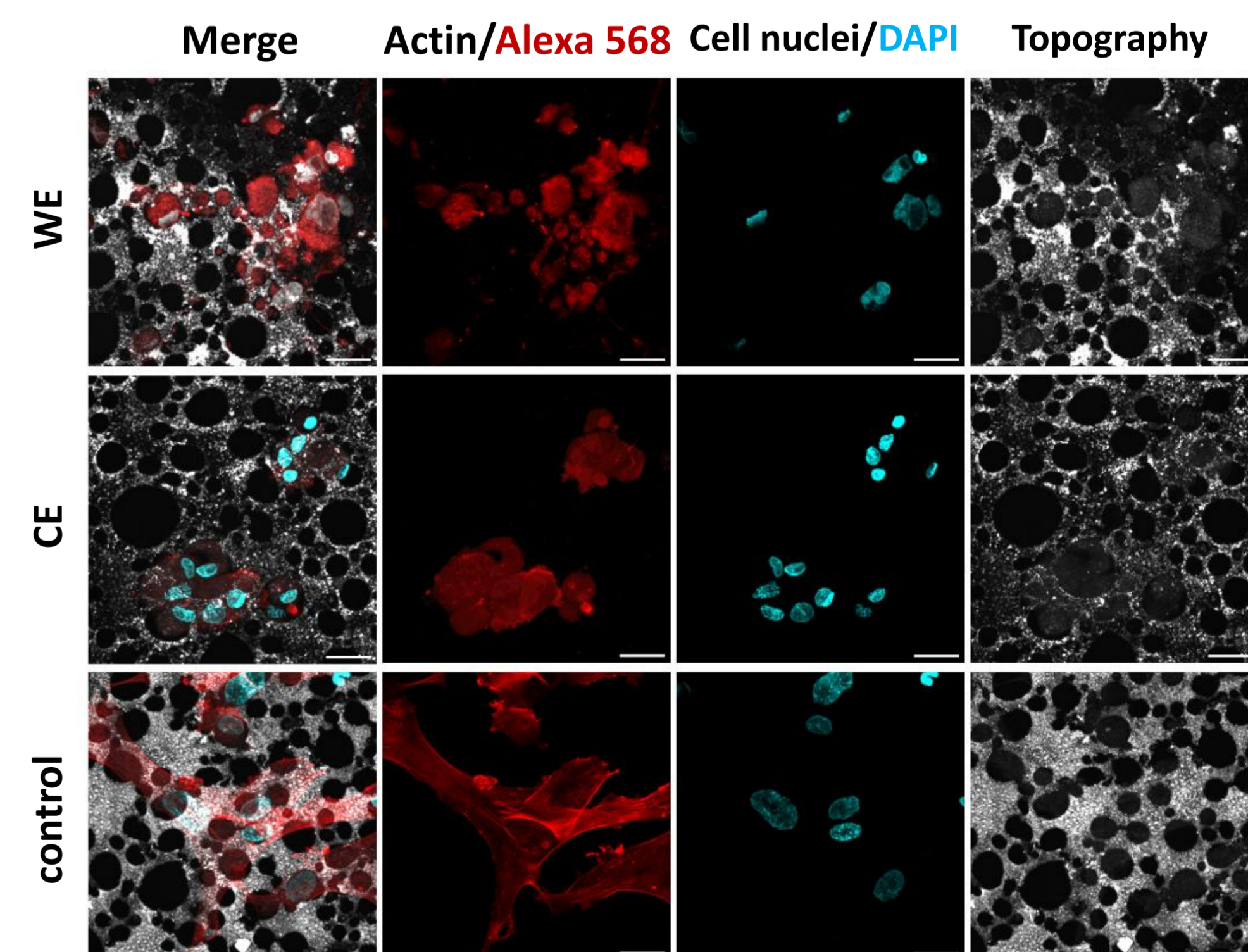
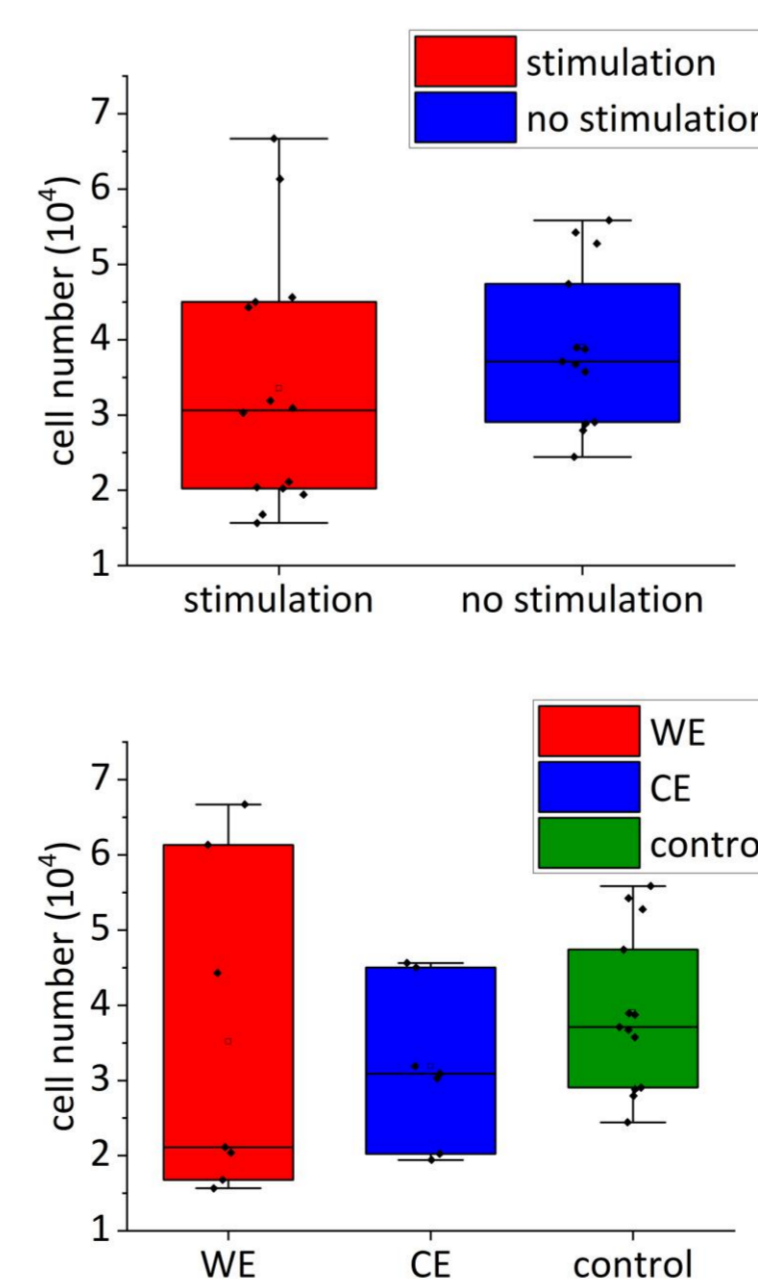


Tracking the actuation behavior



Cell behavior of human dermal fibroblasts after 5h of electro-mechanically stimulation *in vitro*

Cytotoxicity via DNA-assay



- 5h of electromechanically stimulation had no cytotoxic effect on cells
- Stimulated human dermal fibroblasts showed bleb-based cell motility

Conclusion

- 4D microporous and electroactive scaffolds were successfully processed by the functionalization of a polyHIPE-scaffold with a conducting polymer
- Actuation behavior could be tracked by LSCM and image analysis
- PolyHIPE-PEDOT scaffolds showed same actuation response at WE as well as at CE/Ref.
- 5h of electromechanical stimulation had no cytotoxic effect on human dermal fibroblasts
- Electromechanical stimulation lead to changed cell phenotype of human dermal fibroblast, characteristic for cell migration

Acknowledgments

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References

1. A. Ferrández-Montero, B. Carlier, R. Agniel, J. Leroy-Dudal, C. Vancaeyzeele and C. Plesse, 4D smart porous scaffolds based on the polyHIPE architecture and electroactive PEDOT, *J. Mater. Chem. C*, 2021, 9, 12388-12398