Self-powered piezoelectric microdevices for wireless electrical stimulation of cells

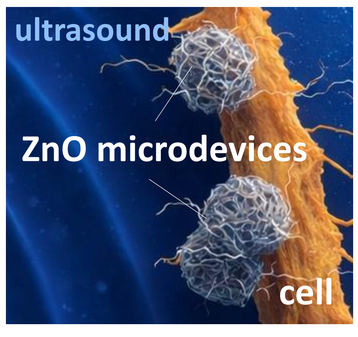
Laura Lefaix,[1] Marc Navarro,[1] Jaume Esteve,[1] Carme Nogués,[2] Andreu Blanquer,[2] Gonzalo Murillo[1*]

1. Instituto de Microelectronica de Barcelona, Centro Nacional de Microelectrónica (IMB-CNM, CSIC)
2. Departament de Biologia Cel·lular, Fisiologia i Immunologia, Universitat Autònoma de Barcelona (UAB)

INTRODUCTION

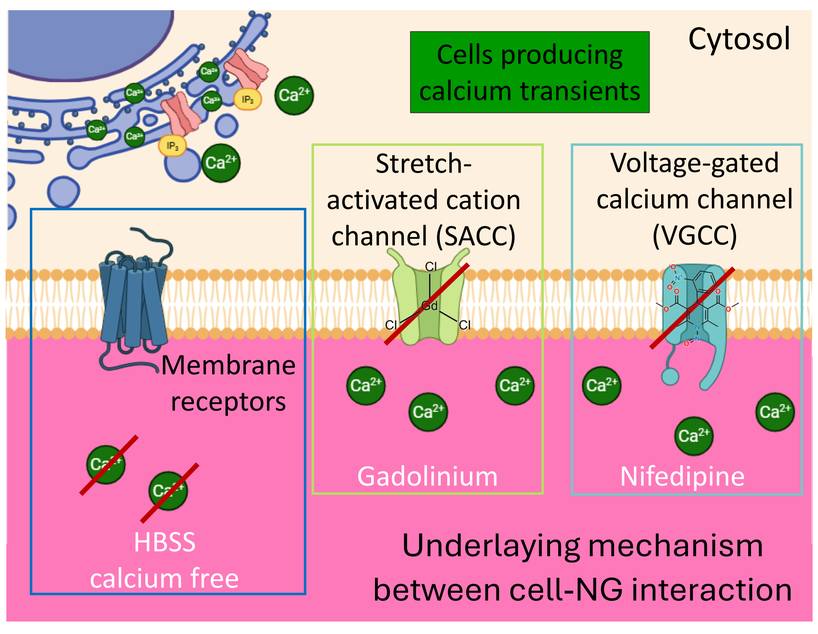
Bioelectronic medicine aims to treat diseases by stimulating electrically active tissues. New bioelectronics applications include reduced electronic devices, like wireless motes for nerve, brain and muscle stimulation or wearables patches for wound healing and to improve cardiac function after infraction. This **miniaturization could allow single-cell interaction and decrease invasiveness** with the possibility of integrating circuitry and improving the level of smartness of the microdevice.

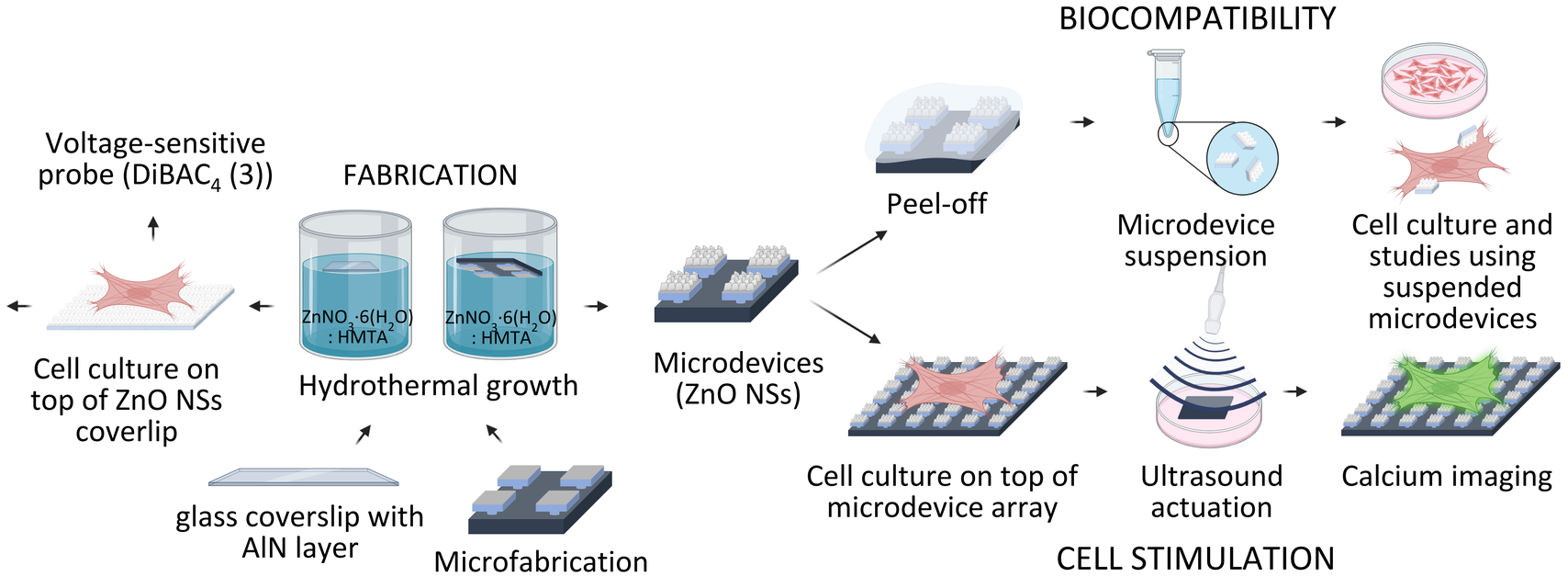
OBJECTIVE



To optimize and characterize a **ZnO NSs–based piezoelectric microdevice** smaller than a cell designed to generate an electric field for the stimulation of cells. Thus, to evaluate the **cytocompatibility and functional effectiveness** of the microdevices in **promoting cell stimulation**.

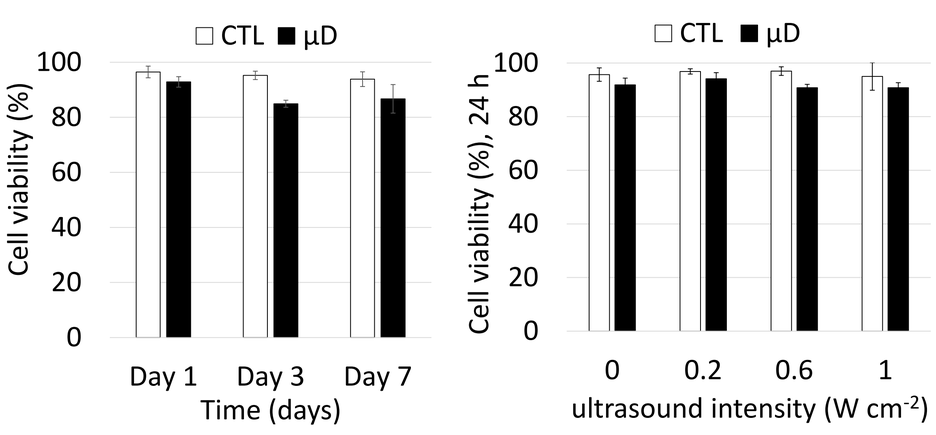
METHODS



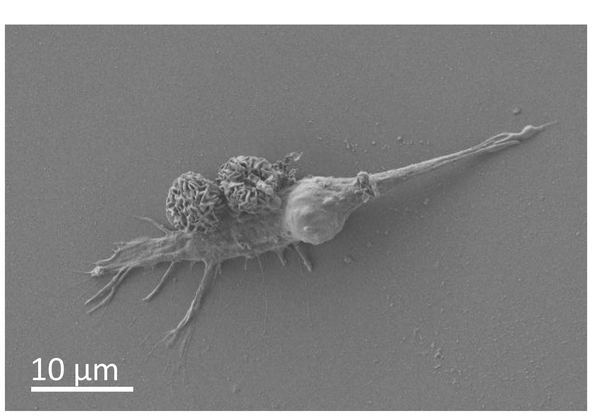


RESULTS

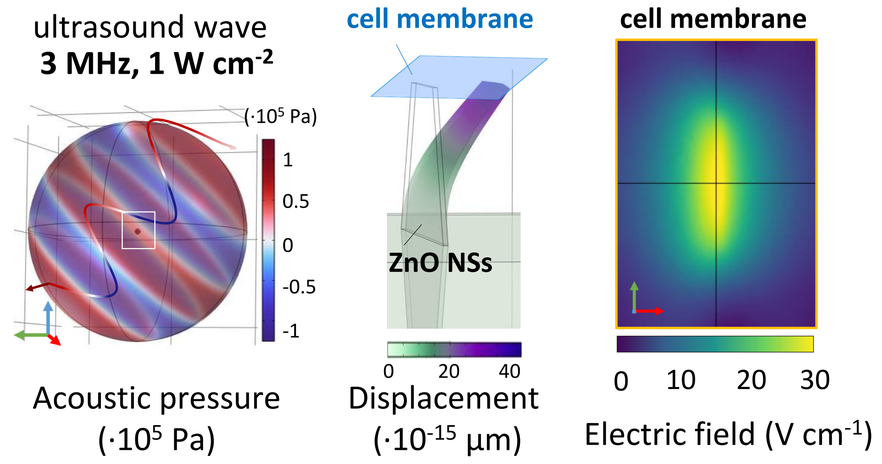
Cell viability (microdevices and actuation)



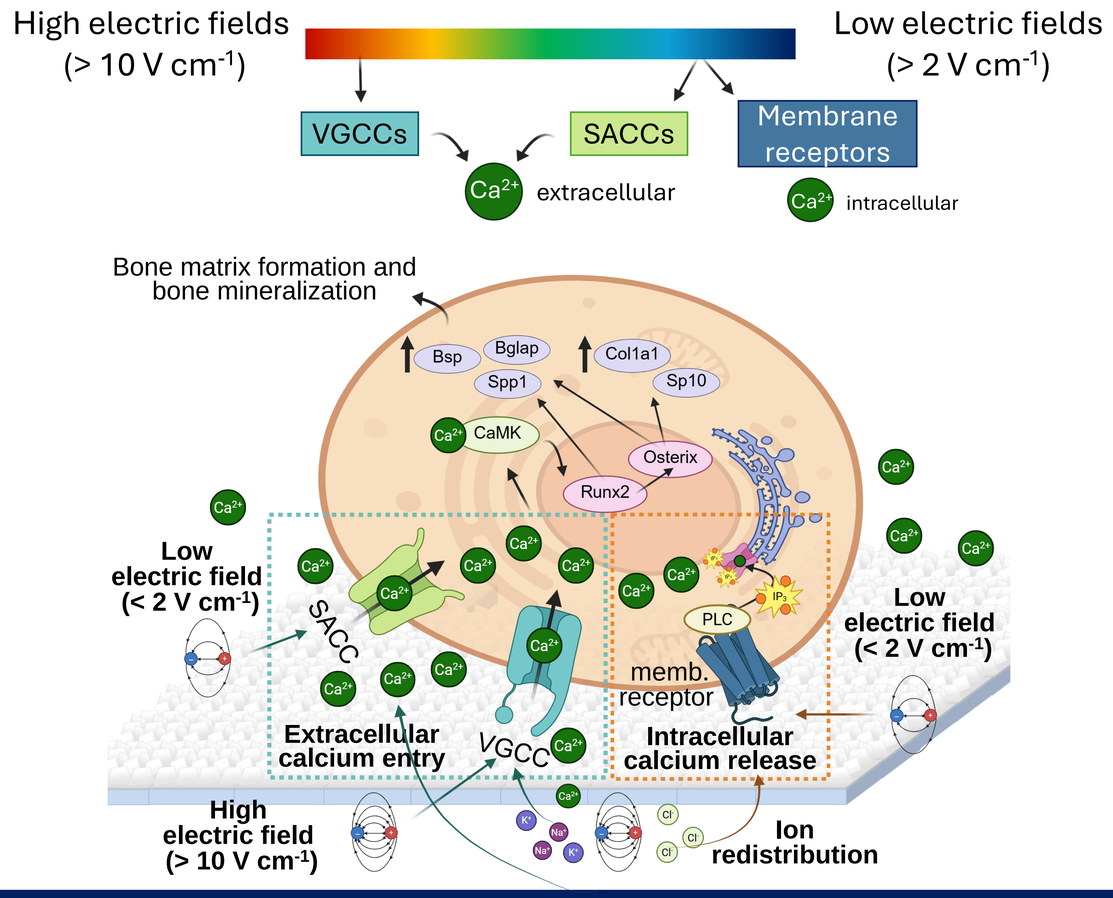
Cell-microdevice interaction



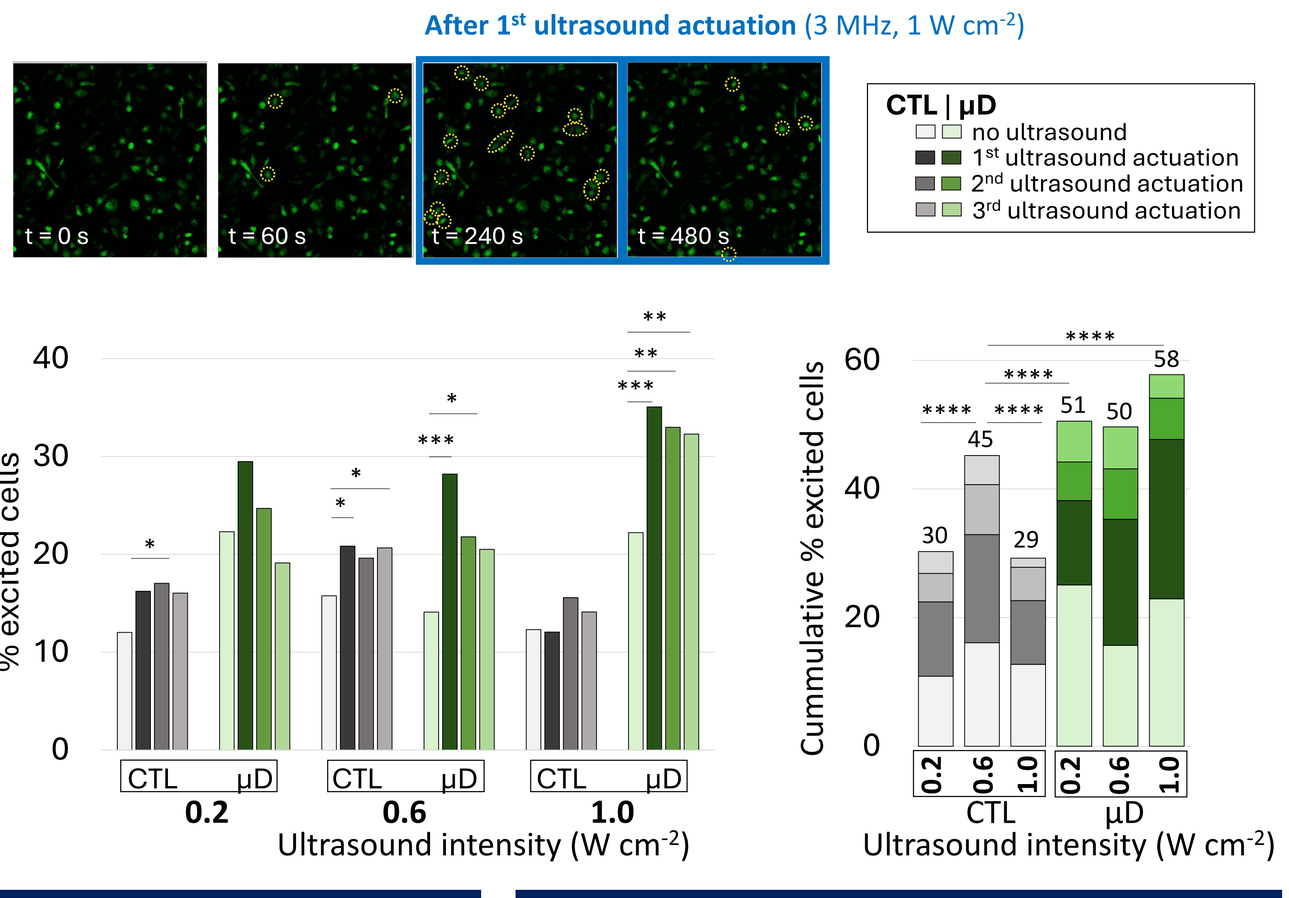
COMSOL Multiphysics simulations



Hypothesized mechanism of the electromechanical cell-NG interaction



Calcium transients in Saos-2 cells after the ultrasound actuation of microdevices



CONCLUSIONS

- **Wireless piezoelectric microdevices, smaller than a mammalian cell**, were fabricated using scalable and highly-reproducible microfabrication techniques.
- The **microdevices and the application of ultrasound** proved to be **cytocompatible.**
- **FEM simulations indicated that a single NS actuated** by ultrasound at 3 MHz (0.2, 0.6 and 1.0 W cm^{-2}) can **generate an electric field intensity sufficient to trigger VGCC**, reinforcing experimental results.
- Remote ultrasound-actuated microdevices provoke a **notable increase in the number of Saos-2 cells presenting calcium transients,** mainly mediated by extracellular calcium entry, through **VGCCs and SACCs.**

ACKNOGLEDGEMENTS

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