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Life Sciences Reporting Summary

Nature Research wishes to improve the reproducibility of the work that we publish. This form is intended for publication with all accepted life science papers and provides structure for consistency and transparency in reporting. Every life science submission will use this form; some list items might not apply to an individual manuscript, but all fields must be completed for clarity.

For further information on the points included in this form, see Reporting Life Sciences Research. For further information on Nature Research policies, including our data availability policy, see Authors & Referees and the Editorial Policy Checklist.

Please do not complete any field with "not applicable" or n/a. Refer to the help text for what text to use if an item is not relevant to your study.
For final submission: please carefully check your responses for accuracy; you will not be able to make changes later.

Experimental design

1. Sample size

Describe how sample size was determined.

No sample size calculations were performed. The sample size (n) of each experiment is provided in the corresponding figure captions in the main manuscript and supplementary information files. Sample sizes were chosen to support meaningful conclusions.

2. Data exclusions

Describe any data exclusions.

No data was excluded from the analyses.

3. Replication

Describe the measures taken to verify the reproducibility of the experimental findings.

All in vitro experiments were replicated successfully 2 or 3 times. In vivo optical IOP measurements were conducted on one sensor of each type and were replicated successfully 2 times while immunofluorescence microscopy on the retrieved sensors was conducted once.

4. Randomization

Describe how samples/organisms/participants were allocated into experimental groups.

In the reported experiments, each group consisted of identically engineered samples. The work does not involve participant groups. Therefore, randomization was not relevant the study.

5. Blinding

Describe whether the investigators were blinded to group allocation during data collection and/or analysis.

Methods for group allocation, data collection and all related analyses were predetermined. Furthermore, the work does not involve participant groups. Therefore, blinding was not relevant to the study.

Note: all in vivo studies must report how sample size was determined and whether blinding and randomization were used.

6. Statistical parameters

For all figures and tables that use statistical methods, confirm that the following items are present in relevant figure legends (or in the Methods section if additional space is needed).

n/a	Confirmed
☐	☒ The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement (animals, litters, cultures, etc.)
☐	☒ A description of how samples were collected, noting whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☐	☒ A statement indicating how many times each experiment was replicated
☐	☒ The statistical test(s) used and whether they are one- or two-sided *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☒	☐ A description of any assumptions or corrections, such as an adjustment for multiple comparisons
☐	☒ Test values indicating whether an effect is present *Provide confidence intervals or give results of significance tests (e.g. P values) as exact values whenever appropriate and with effect sizes noted.*
☐	☒ A clear description of statistics including central tendency (e.g. median, mean) and variation (e.g. standard deviation, interquartile range)
☐	☒ Clearly defined error bars in all relevant figure captions (with explicit mention of central tendency and variation)

See the web collection on statistics for biologists for further resources and guidance.

Software

Policy information about availability of computer code

7. Software

Describe the software used to analyze the data in this study.	COMSOL 5.3, ImageJ 1.51, Lumerical 8.19.1416, Matlab R2016b, Prism Graphpad 7.0d, Zeiss ZEN 2.1

For manuscripts utilizing custom algorithms or software that are central to the paper but not yet described in the published literature, software must be made available to editors and reviewers upon request. We strongly encourage code deposition in a community repository (e.g. GitHub). *Nature Methods* guidance for providing algorithms and software for publication provides further information on this topic.

Materials and reagents

Policy information about availability of materials

8. Materials availability

Indicate whether there are restrictions on availability of unique materials or if these materials are only available for distribution by a third party.	No unique materials were used.

9. Antibodies

Describe the antibodies used and how they were validated for use in the system under study (i.e. assay and species).	This work used Alexa Fluor 594 anti-MMP2 antibody, an anti-MMP2 antibody directly conjugated with the alexa fluor 594 dye (Cat.# 679904) at a 1:500 dilution. The dye was purchased from BioLegend Inc (San Diego, CA 92121), Clone # M6303D01, Lot #B212008 - "https://www.biolegend.com/de-de/products/alexa-fluor-594-anti-mmp2-antibody-12822".

10. Eukaryotic cell lines

a. State the source of each eukaryotic cell line used.	The HeLa cells used in this work were purchased from ATCC.
b. Describe the method of cell line authentication used.	None of the cell lines have been authenticated.
c. Report whether the cell lines were tested for mycoplasma contamination.	The cell lines were not tested for mycoplasma contamination.
d. If any of the cell lines used are listed in the database of commonly misidentified cell lines maintained by ICLAC, provide a scientific rationale for their use.	No commonly misidentified cell lines were used.

Animals and human research participants

Policy information about studies involving animals; when reporting animal research, follow the ARRIVE guidelines

11. Description of research animals

Provide all relevant details on animals and/or animal-derived materials used in the study.	New Zealand white Rabbit, female, 2.5kg, 5 months old.

Policy information about studies involving human research participants

12. Description of human research participants

Describe the covariate-relevant population characteristics of the human research participants.	The study did not involve human research participants.