

Reporting Summary

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Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a Confirmed

- ☐ ☒ The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement
- ☐ ☒ A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
- ☒ ☐ 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 all covariates tested
- ☒ ☐ A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
- ☐ ☒ A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
- ☒ ☐ For null hypothesis testing, the test statistic (e.g. F , t , r) with confidence intervals, effect sizes, degrees of freedom and P value noted
Give P values as exact values whenever suitable.
- ☒ ☐ For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
- ☒ ☐ For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
- ☒ ☐ Estimates of effect sizes (e.g. Cohen's d , Pearson's r), indicating how they were calculated

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

Policy information about [availability of computer code](#)

Data collection	The material luminescence response was recorded using a fiber optic spectrometer (Ocean Optics QE Pro) and Edinburgh FS5 fluorescence spectrophotometer (Edinburgh Instruments Ltd, U.K.). Transmission spectra of the pH sensor film in solutions with different pH values were measured using a spectrophotometer (Cary Series UV-Vis-NIR, Agilent). Data were collected using a Dialog Semiconductor microcontroller DA14585 and visual studio 2015. Custom application codes used for data analysis and display in this paper can be found at https://github.com/yly1994/Swallowable-X-ray-Dosimeter-.git
Data analysis	MATLAB 2020 (Regression Learner and Neural Network Fitting application toolboxes) for data analysis, COMSOL Multiphysics 5.6 for simulation.

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio [guidelines for submitting code & software](#) for further information.

Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our [policy](#)

The main data supporting the results in this study are available within the paper and its Supplementary Information. All data generated in this study, including source data and the data used to make the figures, are available for research purposes from the corresponding author on reasonable request.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☒ Life sciences ☐ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see [nature.com/documents/nr-reporting-summary-flat.pdf](https://www.nature.com/documents/nr-reporting-summary-flat.pdf)

Life sciences study design

All studies must disclose on these points even when the disclosure is negative.

Sample size	We first performed in vitro validation experiments for the accuracy and sensitivity of dose, pH and temperature (Extended Data Fig. 9). The animal experiments were performed to demonstrate the capabilities of the capsule. We determined sample sizes and the number of animals for these in vitro and in vivo experiments on the basis of similar prior studies (refs. 9, 32). We used a total of twelve male rabbits during the testing of the system. Three were used for the stability test of the device, three were used for the angle-dependence test, and 12 were used for the routine blood test. Some rabbits were used in multiple tests on the basis of the reasonable principle of controlled experiments.
Data exclusions	No data were excluded.
Replication	All attempts at replication were successful. In the in vitro testing of the devices (Fig. 4e), the pH, temperature and dose rate tests were repeated 3 times every 16 hours. During in vivo testing of the device, the dose rate test was repeated hourly for a total of 10 repetitions (Fig. 5c), and the pH test was repeated 15 times per minute (Fig. 4d). The angle dependence was replicated using three rabbits (Fig. 4c).
Randomization	Randomization was not relevant for the study, because comparisons of effects between rabbits were not part of it. All rabbits used for the control experiments were of the same type and handled in the same way.
Blinding	Data collection and analysis for each rabbit were performed by different researchers. The personnel completing the data analyses were blinded to the experimental groups.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☐	☒ Animals and other organisms
☒	☐ Human research participants
☒	☐ Clinical data
☒	☐ Dual use research of concern

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Animals and other organisms

Policy information about [studies involving animals](#); [ARRIVE guidelines](#) recommended for reporting animal research

Laboratory animals	Adult male New Zealand white rabbits (90 days old, 1.8~2.2 kg).
Wild animals	The study did not involve wild animals.
Field-collected samples	The study did not involve samples collected from field.
Ethics oversight	All animal experiments were conducted according to the protocol approved by Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences Animal Care and Use Committee.

Note that full information on the approval of the study protocol must also be provided in the manuscript.