READ ME for Research data supporting

"Growth of gas-filled penny-shaped cracks in decompressed hydrogels"

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We provide the following data (**- folders** and - *files*):

- Experimental setup

This folder contains relevant information regarding the construction of our experimental setup.

- multiple view setup 3 (3D) 3D printing design.stl
3D shape of the mirror stand that is printed.

- multiple view setup 3 (3D) 3D printing design mirror shape.dxf
shape of the mirror used in the experimental setup.

- multiple view setup 3 (3D) 3D printing design.dwg
AutoCad file used in the design of the mirror system.

- background.png
image that is displayed as the background in each of the views.

- rendering
folder containing what is used to render the setup using AutoCad.

- Experimental data

This folder contains relevant experimental source data and a few codes to plot them.

- **Example videos**

Repository upload size limits prevented us from sharing all experimental raw videos.

- *single view observation.mov*
Video of the growth of a crack in a single view. It is used to generate figure 1 in the main paper.

- *P40.mxf*
The raw experimental video of data set P40.
Data set P40 was used to generate figures 2, 3, 4, and 6 in the main paper.

- **Data summary**

- *Summary.xlsx / summary.csv*
Contains the input parameters and processed outputs of all the experiments.
Some column headers are explained below:

"Data name": Name of the data label. P data sets are ealier data sets with problems in pressure measurements. Q data sets are later data sets with the pressure measurement issue resolved.

"excess pressure (MPa)": The CO2 pressure in the bottles during the swelling of the beads. Note that there is an error in the values for all P data.

"Modulus (Pa)": The Young's Modulus of bead
Note: the real value is obtained by dividing this (erroneous) value by $\sqrt{2}$, as explained below in the Young modulus code and Data plotting code (the data shown in the paper and ESI are all correct)

"n crack": The number of internal cracks formed in the bead. If this is more than 1, the crack that is analysed will be made clear in the "Data Quality" column.

"n_view": Number of views captured in the view. For all the data, n_view = 4.

"Axis constrain?": The ellipsoid fitting code has an option to constrain the short axis of the fitted ellipsoid. For all except one data point, this option is not used.

"alpha (m/s)": The radius growth rate of the crack from direct image measurement.

"r-t Non linear fit exponent": The radius of the crack can be fitted to time using a power law relation with an initial time offset. This column gives the exponent, but this is likely to be very inaccurate as the initial time offset is treated as a free parameter.

"beta (m^0.5)": Defined as $V = \beta R^{5/2}$ (related to the square root of the elasto-fracture length scale defined in the paper as $\ell = (3\beta/4\pi)^2$ (see inset of Fig. 6b).

"Take?": This column indicates whether a data set is taken. The data set is only taken if this column is 1 or 2. If a data set is not taken, the reason will be explained in the "remarks".

Data sets

Folder containing the data extracted from our experimental videos for all of our valid experiments.

Data sets instructions.pdf
Gives more details about the contents of this folder (not detailed in this document).

- Code

This folder contains the all the code used for raw data processing.

- Video processing

This folder contains the code used to process raw videos (an example of which is P40.mxf).

- Video processing instructions.pdf
This file gives more details about the contents of this folder

- continuous_run_dev2.ipynb
- 3D reconstruction dev1.2 multi.ipynb
- 3D reconstruction dev2.5-lsq-ellipse-direct-axis-contrained-correct.ipynb
These are the three main Jupyter notebooks

- geom_recon, image_proc_lib
These are the folders containing the two accompanying libraries

- Young Modulus

- E determination.ipynb
The Jupyter notebook used to calculate the modulus E of the bead.
Instructions on how to use the code are given as comments in the notebook.
Note:
The kernel of the notebook is the Wolfram Engine 12. There is a free version of the engine compatible with Jupyter. Alternatively, the code can be copied over and run in an actual Mathematica notebook.
Erratum:
There is a error in the code. \textit{d = Power[m0/(4/3*Pi)/1000, 1/3];} in the first cell of code is expected to compute the diameter of the bead, but the expression actually computes the radius. With this error, the value of E and its error computed by the code will be larger than the correct value by a factor of $\sqrt{2}$. While this error is accounted for in the final data we plot in the paper, it is not corrected in this code to maintain consistency with the notebooks in the data sets which all share this problem. For this code to work correctly, the user should therefore replace the code `d = Power[m0/(4/3*Pi)/1000, 1/3];` in the first cell with `d = Power[m0/(4/3*Pi)/1000, 1/3]*2;`

- Diffusion solution

This folder contains the MATLAB code used to solve numerically the full (axial + radial) diffusion problem with moving boundaries discussed in the Electronic Supplemental Information (ESI) §4, and whose key results were quoted in the main paper.

Instructions:
- *main.m* solves the equation (parameters can be adjusted, all in SI units, and time is not scaled).
  In particular, the mesh size can be adjusted using 'HMax' option in line 27.
  After running main.m, run the post-processing codes (used to plot Fig. 6 in the ESI):
- *post_proc3.m* exports density plots of the concentration.
- *post_proc4.m* computes the flux over time.

- Data plotting code

This folder contains the MATLAB code used to post-process and plot the data in the Data sets and Data Summary folders.

- plot fig3.m, plot fig4&6.m, plot fig7.m, plot fig8.m, plot fig8 Q data.mat
Used to plot figures 3, 4, 6, 7, 8 in the main paper
- P40.m
Summarising the parameters of experiment P40 used in figures 3,4,6
- S_T_ps.m, Diffusivity_T.m, Henry_T.m
Utility functions to compute $S(T, p_s)$, $D(T)$, $k_h(T)$ from tabulated values.