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Supplementary information for manuscript:

3D characterization of kinematic fields and poroelastic swelling near the tip of a propagating crack in a hydrogel

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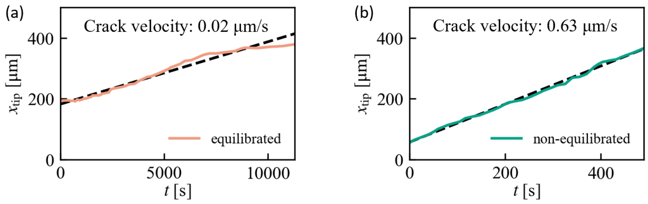

Fig. S1 Crack tip position (in reference frame, with zero located at its left edge) with respect to time for (a) the equilibrated crack and (b) the non-equilibrated crack. The crack velocity is determined through linear regression, resulting in 0.02 μm/s for the equilibrated crack and 0.63 μm/s for the non-equilibrated crack.

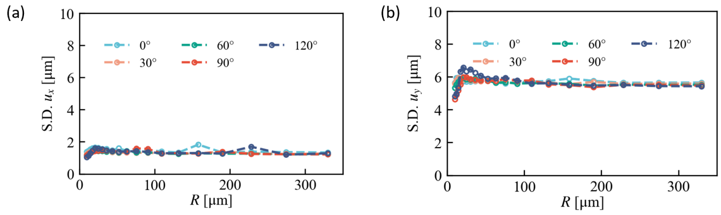

Fig. S2 Standard deviation of the interpolation of (a) u_x and (b)u_y for a total of 53 frames, corresponding to the average values shown in the maintext Fig. 4.

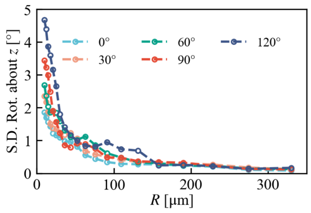

Fig. S3 Standard deviation of the interpolation of rotation about Z-axis for a total of 53 frames, corresponding to the average values shown in the maintext Fig. 5(b).

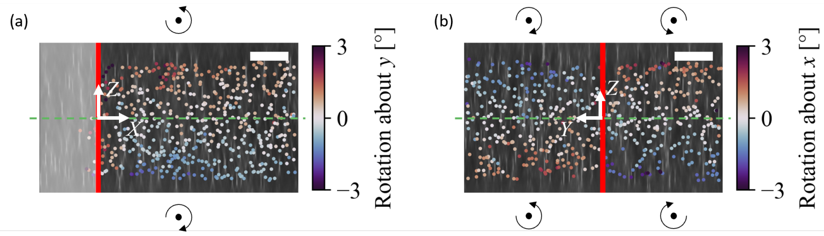

Fig. S4 Out-of-plane rotation is observed both about (a) y-axis and (b) y-axis. (a) Rotation about y-axis for the particles on the crack front xz-plane (within $\pm 10\,\mu m$). The crack front is indicated by the orange dashed line, and the mid-plane of the sample is indicated by the red dashed line. (b) Rotation about x-axis for the particles on a yz-plane ($100\,\mu m \pm 10\,\mu m$ ahead of the crack tip. The horizontal red dashed line indicates the mid-plane of the sample and the vertical red dashed line indicates the crack front xz-plane. The circular arrows in both panels serve as the guide to the eye for the direction of the rotation. The scale bar is $100\,\mu m$.

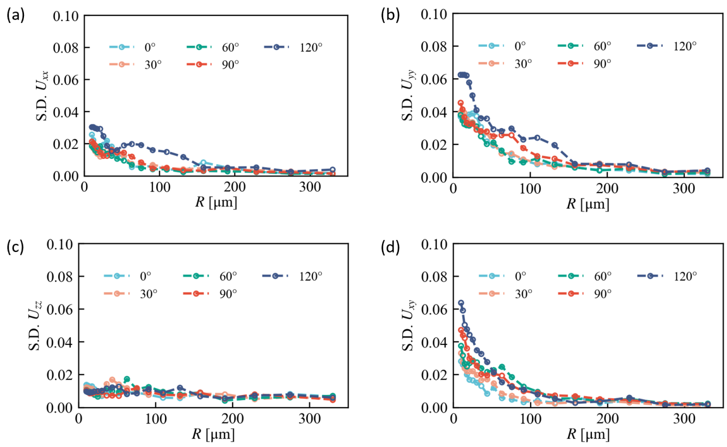

Fig. S5 Standard deviation of the interpolation of (a) U_{xx}, (b) U_{yy}, (c) U_{zz}, and (d) U_{xy} for a total of 53 frames, corresponding to the average values shown in the maintext Fig. 7.

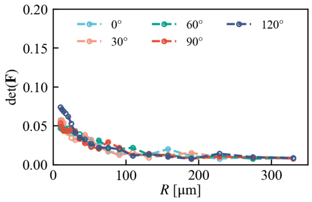

Fig. S6 Standard deviation of the interpolation of det(**F**) for a total of 53 frames, corresponding to the average values shown in the maintext Fig. 8(c).

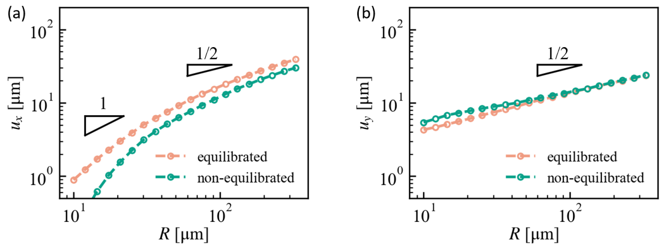

Fig. S7 The comparison of displacement (c) u_x and (d) u_y for both equilibrated and non-equilibrated cracks at points along $\Theta = 30°$ in the mid-plane of the sample (not comparing $\Theta = 0$ because $u_y \approx 0$ when $\Theta = 0$). Values are interpolated independently in the reference frame and averaged over frames for both cracks. The magnitude of u_x for the equilibrated crack is slightly larger than that for the non-equilibrated crack, whereas the values of u_y are similar for both cracks, particularly after $R > 100\,\mu\text{m}$. Both cracks exhibit a $\sqrt{R}$ rate for the displacement u_x and u_y at $R > 100\,\mu\text{m}$; as approaching to the crack tip, u_x decreases more rapidly for the non-equilibrated crack than for the equilibrated crack.

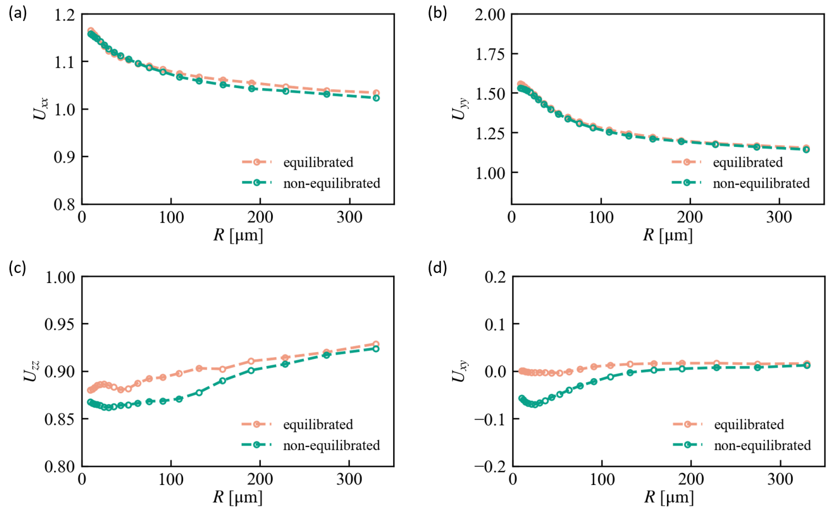

Fig. S8 The comparison of stretch components (a) U_{xx}, (b) U_{yy}, (c) U_{zz}, and (d) U_{xy} for both equilibrated and non-equilibrated cracks. Data are interpolated and averaged at points same as in Fig. S7(c) and (d). Both cracks exhibit similar values of stretch U_{xx} and U_{yy}. For the non-equilibrated crack, U_{zz} is slightly lower but U_{xy} (magnitude) is slightly larger compared to the equilibrated crack.

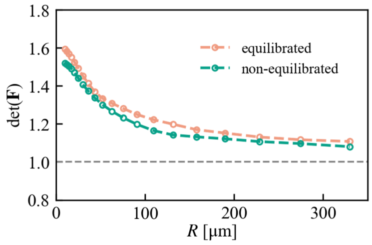

Fig. S9 The comparison of det($\mathbf{F}$) for both a equilibrated and non-equilibrated crack. Generally, the volumetric change for the equilibrated crack is slightly larger that that for the non-equilibrated crack, as indicated by the larger value of det($\mathbf{F}$). Far from the crack tip ($R \approx 300\,\mu$m), det($\mathbf{F}$) maintains a finite value for both cracks due to stretch. In the immediate vicinity of the crack tip, a continuous increase of det($\mathbf{F}$) is observed for the equilibrated crack, while for the non-equilibrated crack, the slope becomes flat. This discrepancy can be attributed to the difference in crack velocity. For the equilibrated crack, the crack is slow enough to facilitate the solvent transport and continuous increase of volume. Conversely, for the non-equilibrated crack, the crack velocity is relatively high (yet still quasi-static), and the solvent does not have sufficient time to migrate from the environment to the internal material, leading to a slower increase in volume, compared to that of the equilibrated crack.