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How cracks are hot and cool: a burning issue for this paper

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Material failure is accompanied by important heat exchange, with extremely high temperature – thousands of degrees – reached at crack tips. Such temperature may subsequently alter the mechanical properties of stressed solids, and finally facilitate their rupture. Thermal runaway weakening processes could indeed explain stick-slip motions and even be responsible for deep earthquakes. Therefore, to better understand and eventually prevent catastrophic rupture events, it appears crucial to establish an accurate energy budget of fracture propagation from a clear measure of the various energy dissipation sources. In this work, combining analytical calculations and numerical simulations, we directly relate the temperature field around a moving crack tip to the part α of mechanical energy converted into heat. Monitoring the slow crack growth in paper sheets with an infrared camera, we measure a significant fraction $\alpha = 12 \pm 4\%$. Besides, we show that (self-generated) heat accumulation could weaken our samples with microfibers combustion, and lead to a fast crack/dynamic failure/ regime.

Reference: Toussaint, R., Lengliné, O., Santucci, S., Vincent-Dospital, T., Naert-Guillot, M. and Maloy, K.J., How cracks are hot and cool: a burning issue for paper (2016), Soft Matter (12), 5563-5571, DOI: 10.1039/C6SM00615A