Statistical mechanics of fracture phenomena and brittle-to-ductile transitions

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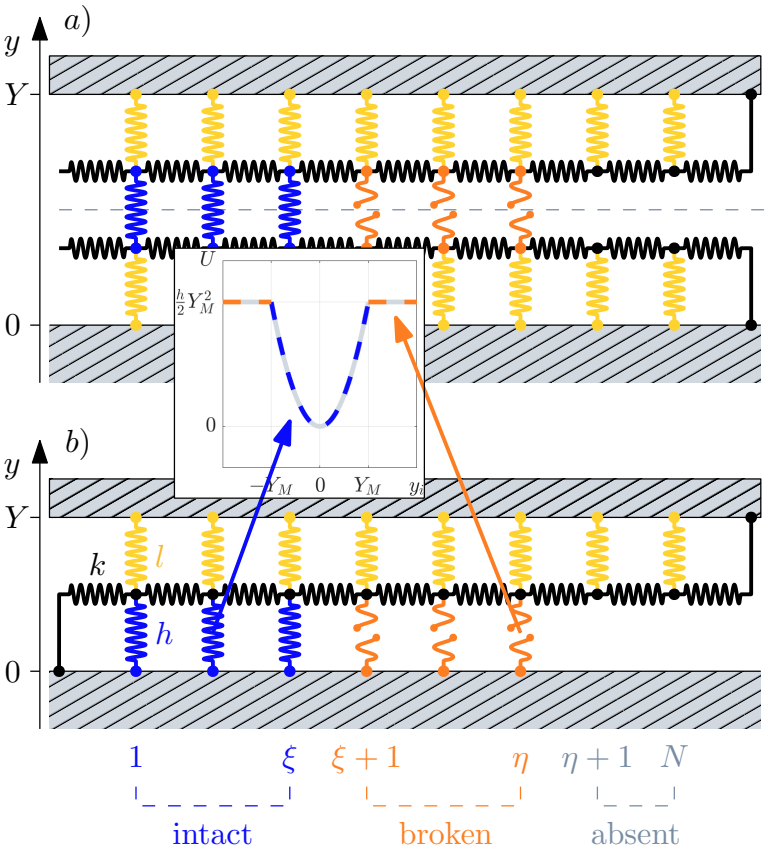
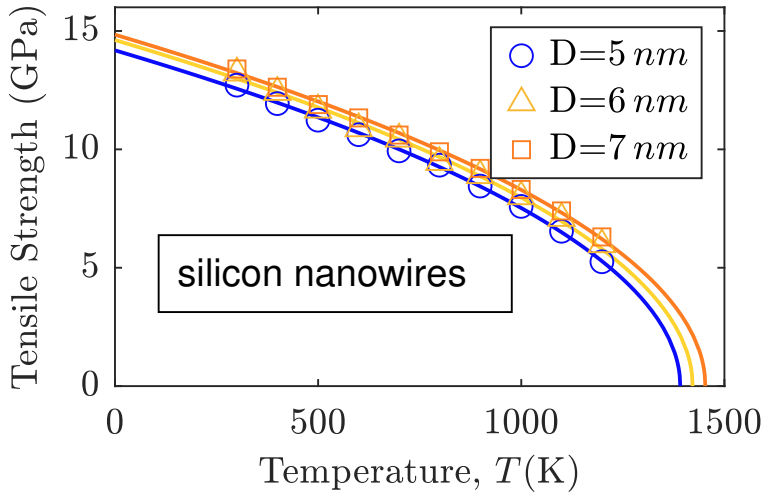
Rencontre du Non-Linéaire 2023
March 29, 2023

Brittle fracture model

We obtain the temperature dependence of **Griffith fracture stress** in brittle materials as a **phase transition** of statistical mechanics (successfully compared with MD simulations).



$$\sigma_s = hY_M(1-\phi)\sqrt{\frac{l}{l+h}}\sqrt{1-\frac{T}{T_c}}$$

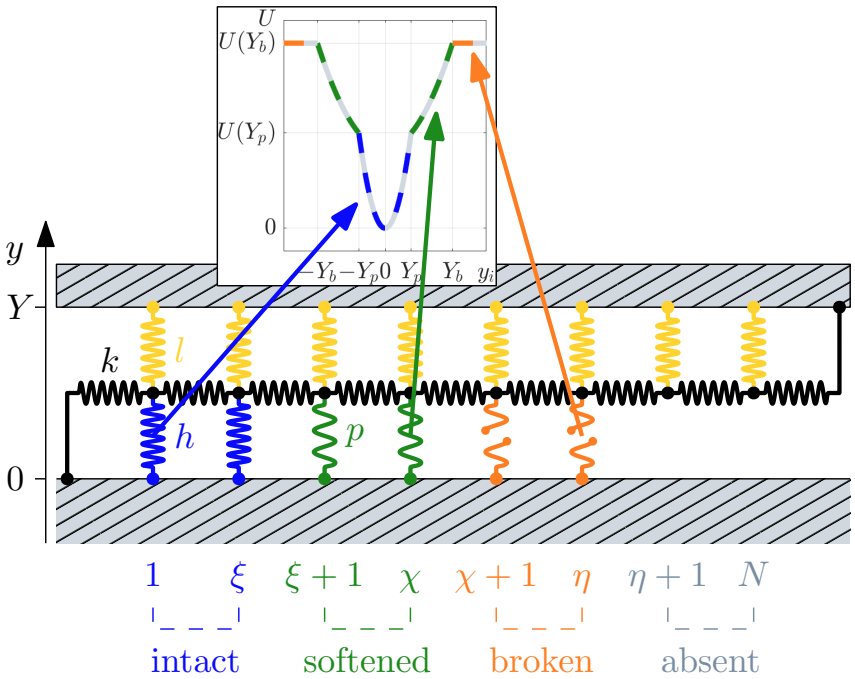


[1] Physical Review E **107**, 035001 (2023)

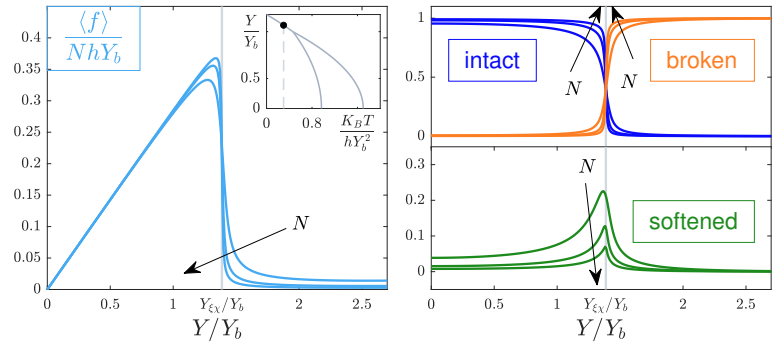
[2] J. Phys. A: Theor. **54** (2021) 445001

Brittle-to-ductile fracture model

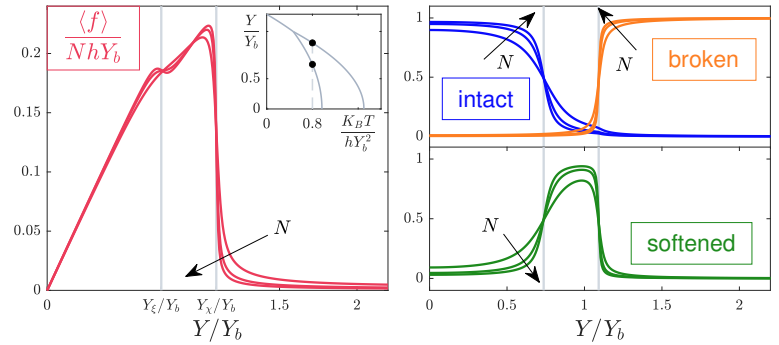
Softenable nonlinear bonds are able to reproduce the **cohesive zone** and the thermally induced **brittle-to-ductile transition** of fracture (at $T = T^*$).



Cold $T < T^*$:



Hot $T > T^*$:



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