# Response of biofilament networks dictated by the physical properties of crosslinkers

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It is well-known that the mechanical response of live cells is largely determined by the cytoskeleton, a network consisting of different bio-filaments such as F-actin and microtubules that are interconnected and bundled together by a variety of crosslinking proteins.

Here we present a computational investigation on how the bulk behavior of a biopolymer network is governed by its crosslinking molecules. Specifically, a combined finite element – Langevin dynamics (FEM-LD) approach was employed to simulate the deformation of randomly cross-linked F-actin networks where, besides bending and stretching, thermal fluctuations of individual filament have also been taken into account. The cross-linker is modeled as a combination of linear and rotational springs that resists both separation and relative rotation between two filaments and disengages from the F-actin once the strain energy stored inside reaches a critical level. It was found that networks with compliant cross-linkers, such as $\alpha$-actinin, exhibit low bulk moduli with no apparent strain-hardening because most of the imposed strain was actually absorbed by those highly-deformable crosslinking molecules. In addition, we showed that increasing the rotational spring stiffness of cross-linkers will lead to a more homogeneous load distribution, as well as deformation, within the network. Interestingly, stress-strain curves obtained from our simulations are decorated with sudden load drops, corresponding to the breakage of individual crosslink points, which demonstrates that deformation will generally progress in a non-smooth fashion. Finally, the influence of entropy was found to be important only when the strain level is low (less than ~1%) while the network response is dominated by elasticity at large strains. Nevertheless, thermal fluctuations of F-actin seem to always advance the onset of crosslink breakage. Connections between our results and various experimental findings will also be discussed.