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Microrheology of highly crosslinked microtubule networks is dominated by force-induced crosslinker unbinding MEGAN VALENTINE, YALI YANG, University of California, Santa Barbara, MO BAI, WILLIAM KLUG, ALEX LEVINE, University of California, Los Angeles — We determine the viscoelastic responses of reconstituted networks of microtubules that have been strongly bonded by labile crosslinkers using a magnetic tweezers device to apply localized forces. At short time scales, the networks respond nonlinearly to applied force, with stiffening at small forces, followed by a reduction in the stiffening response at high forces, which we attribute to the force-induced unbinding of crosslinks. At long time scales, force-induced bond unbinding leads to local network rearrangement and significant bead creep. Interestingly, for rigidly crosslinked networks, the material retains its elastic modulus even under conditions of significant plastic flow, suggesting that crosslinker breakage is balanced by the formation of new bonds. To better understand this effect, we developed a finite element model of such a stiff filament network with crosslinkers obeying force-dependent Bell model unbinding dynamics. The coexistence of dissipation, due to bond breakage, and the elastic recovery of the network is possible because each filament has many crosslinkers. Recovery can occur as long as a sufficient number of the original crosslinkers are preserved under the loading period. When these remaining original crosslinkers are broken, plastic flow results.

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