mechanical principles can be extended to three-dimensional mechanical self-assembly and demonstrated for fabricating gear-like microstructures.

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09:40–Ballroom B

Wrinkling mode evolution in hyperelastic film/substrate bilayers

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Wrinkling modes are determined for a two-layer system comprised of an elastic film bonded to an infinitely deep pre-stretched elastomeric substrate with the entire bilayer undergoing compression. Nonlinear finite element simulations uncover advanced post-bifurcation modes. Both numerical simulations and theoretical analysis have been performed to reveal the underlying physics behind the wrinkling mode evolution.

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10:00–Ballroom B

An anisotropic discrete fiber model based on a generalized strain invariant with application to soft biological tissues

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A classical continuum model of fibrous connective tissues considers the tissue as a composite of fiber bundles and an isotropic matrix. A distribution function characterizes the orientation of an infinite number of identical fiber bundles. In addition, an undulation distribution determines the nonlinear response of each fiber bundle to stretching. Here, a new discrete fiber model is developed for nonlinear anisotropic elastic response of tissues which can reduce to an isotropic model as a speical case. Specifically, a generalized strain invariant is defined as a weighted sum of scalar quantities dependent on the right Cauchy–Green deformation tensor and six structural tensors defined by a regular icosahedron. The connective tissue is modeled as an incompressible composite of fibers and an inviscid fluid matrix. The fibers are modeled by a strain energy that is a nonlinear polynomial function of this generalized invariant. Examples show that this model can accurately simulate the nonli

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10:20–Ballroom B

Mechanical regulation of receptor-ligand binding by controllable transport

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Binding and unbinding of receptor-ligand bonds in cell adhesion are commonly characterized by measuring association and dissociation kinetic rate constants. The force dependence of bond dissociation has been extensively studied at single-molecule level, while quantification of bond association kinetics is much scattered and its detailed regulation mechanisms remain to be fully understood. Here we theoretically and experimentally investigate the interplay of association kinetics between surface-bound receptors/ligands and transport of protein carrier via diffusion process in a biomembrane force probe (BFP). Dependent of mechanical aspects that control carrier transport, the mean waiting time for receptor-ligand binding to occur augments monotonically with increasing gap distance between the functional surfaces. We gain quantitative understanding of how diffusive transport mechanism can alter the apparent binding behavior of molecular interactions, and better interpretation of intrinsic association rate constant through proper modeling the pertinent experiments.

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SM01: Biomechanics and biomaterials

11:00–12:40, Friday, 24 August
Pasquale Ciarletta, France, Chair
Jin Qian, China, Chair
Room: Ballroom B

11:00–Ballroom B

Binding biomechanics of recombinant human beta 2 integrin

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LFA-1 and Mac-1, two β_2 integrin members constitutively expressed on neutrophils, mediate various stages of leukocyte recruitment cascade by binding to the same ligand of ICAM-1. The slow rolling and firm adhesion of leukocytes rely on LFA-1 while the cell crawling is dependent on Mac-1. We hypothesized that their distinct roles are likely attributed to the differences in the binding kinetics or in the diverse responses of outside-in and inside-out signaling. Here we constructed the Fc-fused wild type (WT) human LFA-1 and Mac-1 molecules and their high affinity (HA) mutants, and quantified their ICAM-1 binding features using optical trap technique. Our data indicated that the affinity up-regulation from WT to HA is off-rate dependent for LFA-1 but on-rate dependent for Mac-1. The structural bases of this new finding were found to be consistent with our previous simulations. These results furthered our understanding in their function differences under shear flow.

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