**Anisotropy**

* **Phase-Field Models for the Failure of Anisotropic Continuum (*Conference proceedings of work below)***
* **Authors: Dal, Gultekin, Denli, Holzapfel**
  + Phase-field approach for an anisotropic continuum
  + Fracture of biological tissues and fiber reinforced composites
  + Energy based anisotropic failure criterion
  + One-pass operator-splitting algorithm
* **Numerical aspects of anisotropic failure in soft biological tissues favor energy-based criteria: a rate-dependent anisotropic crack phase-field model**
* **Authors: Gultekin, Dal and Holzapfel**
  + Captures anisotropic fracture using an anisotropic volume-specific crack surface function
    - Thermodynamically consistent, based on finite strains
  + Invariant based anisotropic material model > ground matrix and collagenous components
  + Overcomes shortcomings (curvilinear crack paths and branching angles) using energy minimization
  + Diffusive crack topology > spread out the sharp crack surface over a solid domain regularized by a length scale parameter l
* **Crack Phase-Field Modeling of Anisotropic Rupture in Fibrous Soft Tissues**
* **Authors: Gultekin, Dal and Holzapfel**
  + Energy based anisotropic criteria (same as last two papers)
    - Crack growth in fiber direction
  + Presents a comparison to other anisotropic failure criteria
    - E.g. Hill Criterion, Tsai-Wu Criterion
    - Stress-based criteria are susceptible to instabilities > convergence becomes difficult
* **Phase-field modeling and simulation of fracture in brittle materials with strongly anisotropic surface energy**
* **Authors: *Bin Li*, Peco, Millan, Arias, and Arroyo**
  + Phase-field model for brittle fracture of materials with *strongly* anisotropic surface energy
    - Forbidden crack propagation directions, guiding cracks along high-energy directions, sawtooth patterns
  + Cahn-Hilliard framework for crystal growth

**Brittle Fracture (Some Papers Cited in Li et. al.)**

* **Revisiting Brittle Fracture as an Energy Minimization Problem**
* **Authors: G.A. Francfort and J.J. Marigo**
  + Variational free-discontinuity generalization of Griffith’s theory for brittle fracture
    - Addresses crack nucleation, path selection, and discontinuous crack propagation
  + Driving Principle/Assumption
    - At any time, the loaded sample wants to minimize the sum of its bulk and surface energies
* **The Variational Approach to Fracture**
* **Authors: Bourdin, Francfort, Marigo**
  + Extended Griffith’s theory with a new criterion of rupture
    - Equilibrium position is one in which rupture of the solid has occurred
    - Continuous decrease in potential energy
* **Revisiting Brittle Fracture as an Energy Minimization Problem**
* **Authors: Francfort and Marigo**
  + Variational free-discontinuity generalization of Griffith’s theory
  + Driving Principle/Assumption: at any time the loaded sample wants to minimize the sum of its bulk and surface energies
* **Phase field modeling of fracture in multi-physics problems. Part I. Balance of crack surface and failure criteria for brittle crack propagation in thermos-elastic solids**
* **Authors: Miehe, Schanzel, and Ulmer** 
  + Introduction of a balance of regularized crack surface, governed by a crack phase field
  + Crack surface density function: describes the macroscopic crack surface in the bulk material per unit of the reference volume
  + Generalization of crack driving forces from the energetic definitions towards stress-based criteria

**Damage**

* **A phenomenological model of damage in articular cartilage under impact loading**
* **Authors: Argatov and Mishuris**
  + Treats cartilage as a biphasic poroelastic material > accounts for viscous dissipation
  + Introduces a kinetic damage evolution law and fracture criterion
* **An uncoupled directional damage model for fibered biological soft tissues. Formulation and computational aspects**
* **Authors: Calvo, Peña, Martinez, and Doblaré** 
  + 3D finite strain (stochastic) damage model for fibrous tissues
  + Internal variables provide a description of materials involving irreversible effects
* **A finite strain integral-type anisotropic damage model for fiber-reinforced materials: application in soft biological tissues**
* **Authors: Fathi, Ardakani, Deheghani, Mohammadi**
  + Large deformation FEM > study anisotropic damage behavior of geometrically nonlinear problems
  + Integral type nonlocal damage model is utilized to circumvent mesh dependency
  + Mechanical response of soft tissues using Neo-Hookean and exponential strain energy functions
  + Effect of characteristic length of soft biological tissues
* **Implementation of a hyperelastic model for arterial layers considering damage and distribution of collagen fiber orientations**
* **Authors: Gajewski, Weisbecker, Holzapfel, and Łodygowski**
  + Implementation of a constitutive equation for arteries considering discontinuous damage and distributed collagen fiber orientations
  + Generalized version by Gasser and Weisbecker includes fiber dispersion and damage respectively
* **A theory for fracture of polymeric gels**
* **Authors: Mao and Anand**
  + Accounts for fluid diffusion, large deformation, damage, and gradient effects of damage
  + Accounts for change in free energy in the internal energy due stretching
  + Damage and failure driven by changes in the internal energy of stretched polymer chains
* **A generic anisotropic continuum damage model integration scheme adaptable to both ductile damage and biological damage-like situations**
* **Authors: Mengoni and Ponthot**
  + General versatile time integration scheme for anisotropic damage coupled to elastoplasticity
    - Considers damage rate and isotropic hardening formulations
  + Development of a biological model for bone remodeling (application, orthodontics)
* **Damage functions of the internal variables for soft biological fibered tissues**
* **Authors: Estefanía Peña**
  + Compares a series of damage functions and proposes a damage function to describe softening in biologics
  + Difference > first derivative is zero at the initial damage state (smooth derivatives
* **On finite-strain damage of viscoelastic-fibered materials. Application to soft biological tissues**
* **Authors: Peña, Calvo, Martínez, Doblaré**
  + 3D finite-strain damage model for visco-hyperelastic fibrous soft tissue
  + Viscoelastic behavior > local additive decomposition of the stress tensor into initial and non-eq parts
  + Used Abaqus knee model to model medial cruciate ligament (MCL)
  + Limitation: evolution equations of viscoelastic internal variables are linear not non-linear
* **On the Mullins effect and hysteresis of fibered biological materials: A comparison between continuous and discontinuous damage models**
* **Authors: Peña, Peña, Doblaré**
  + Compares continuous & discontinuous damage approaches to model softening effects in fibered materials
    - Three approaches: continuum damage mechanics, pseudo-elasticity, hard & soft phase microstructure > Cannot capture Mullins effect and hysteresis
  + Presents a mixed damage model extended for quasi-static loading/unloading to include softening phenomena for matrix and fibers
* **Prediction of the softening and damage effects with permanent set in fibrous biological materials**
* **Authors: Peña**
  + Captures Mullins behavior, damage after unloading
* **Statistical approach for a continuum description of damage evolution in soft collagenous tissues**
* **Author: Schmidt, Balzani, and Holzafel**
  + Statistical approach to describe microscopic damage evolution in soft collagenous tissues
  + Statistical distribution of proteoglycan orientation, fibril length parameters, and PG stretch
* **On a fully 3-D finite-strain viscoelastic damage model: formulation and computational aspects**
* **Authors: Simo**
  + ***Seminal paper on damage -*** Isotropic damage mechanism
  + General anisotropic response, hyperelastic behavior, incorporates softening behavior under deformation
* **An equilibrium constitutive model of anisotropic cartilage damage to elucidate mechanisms of damage initiation and progression**
* **Authors: Stender, Regueiro, Klisch, and Ferguson** 
  + A previous equilibrium constitutive model of articular cartilage (AC) was extended to a constitutive damage AC model
  + 3D formulation considering collagen fibril damage and isotropic glycosaminoglycan (GAG) damage
  + Disadvantage: time dependent effects such as viscoelasticity and poroelasticity not taken into effect
  + Simulated uniaxial tensile loading to failure and spherical indentation into a bilayer sample
* **Layer-specific damage experiments and modeling of human thoracic and abdominal aortas with non-atherosclerotic intimal thickening**
* **Authors: Weisbecker, Pierce, Regitnig, Holzapfel**
  + Novel pseudo-elastic damage model to describe discontinuous softening
  + Compared to experimental data from uniaxial extension tests
* Simulation of discontinuous damage incorporating residual stresses in circumferentially overstretched atherosclerotic arteries
* Authors: Balzani, Schroeder, and Gross
* Hurschler
  + Damage of only collagenous components
* Liao and Belkoff
  + Damage of only collagenous components
* Hakonson and Yazdani
  + Arteries
* Arnoux
  + Ligaments and tendons
* Schectman and Bader
  + Ligaments and tendons
* Rodriguez
  + Stochastic-structurally based model for fibrous soft tissues
  + Takes into account different damage processes for matrix and fibers
    - Requires working on two scale levels
  + Drawback: damage occurs at a lower length scale than the fiber level

**Poroelasticity**

* **A fibril reinforced nonhomogenous poroelastic model for articular cartilage: inhomogenous response in unconfined compression**
* **Authors: Li, Buschmann, and Shirazi-Adl**
  + Takes depth dependence into account > not done reviewing

**Viscoelasticity**

* **Finite deformation biphasic material properties of bovine articular cartilage from confined compression experiments**
* **Authors: Ateshian, Warden, Kim, Grelsamer, and Mow**
  + *Seminal Paper from Mow mentioned here is listed below*
  + Confined compression experiments and theoretical predictions differed by 10% (considered small)
* **Time and depth dependent poisson’s ratio of cartilage explained by an inhomogeneous orthotropic fiber embedded biphasic model**
* **Authors: Chegini and Ferguson** 
  + Biphasic, poroelastic, fiber-embedded cartilage model was developed
  + Matrix was modelled as an inhomogeneous isotropic biphasic material with nonlinear strain dependent permeability
* **Biphasic Poroviscoelastic Simulation of the Unconfined Compression of Articular Cartilage: I Simultaneous Prediction of Reaction Force and Lateral Displacement**
* **Authors: DiSilvestro, Zhu, Wong, Jurvelin, and Suh**
  + Linear biphasic poroelastic (BPE) model
    - Accounted for lateral displacement but did not fit short-term reaction force (RF)
  + Linear Biphasic poroviscoelastic model
    - *Accounted for both lateral displacement and RF for all unconfined compression specimens*
  + Transversely isotropic BPE model
    - Fit both lateral displacement and short-term RF but not simultaneously
  + Linear viscoelastic solid model > only accounted for reaction force
* **Biphasic poroviscoelastic characteristics of proteoglycan-depleted articular cartilage: simulation of degeneration**
* **Authors: DiSilvestro and Suh**
  + Linear? biphasic poroviscoelastic properties of normal and PG-depleted articular cartilage
  + *Strong fit of biphasic poroviscoelastic model for degenerated articular cartilage*
* **Depth and rate dependent mechanical behaviors for articular cartilage: Experiments and theoretical predictions**
* **Authors: Gao, Zhang, Gao, Liu, and Xiao**
  + Depth-dependent nonlinear viscoelastic constitutive model was proposed to predict creep behavior and uniaxial mechanical behavior of cartilage under unconfined compression
  + Reported Poisson’s ratio and Young’s modulus by depth
* **A biphasic viscohyperelastic fibril-reinforced model for articular cartilage: Formulation and comparison with experimental data**
* **Authors: García and Cortés**
  + Viscohyperelastic constitutive equation was used for matrix and fibers
  + Followed experimental stress-strain eq curves under tension and compression for humeral cartilage
* **A nonlinear biphasic viscohyperelastic model for articular cartilage**
* **Authors: García and Cortés**
  + Nonlinear biphasic viscohyperelastic model compared to experiments from DiSilvestro and Suh, and Ateshian
* **The apparent viscoelastic behavior of articular cartilage – The contributions from the intrinsic matrix viscoelasticity and interstitial fluid flows**
* **Authors: A. F. Mak** 
  + Cartilage modeled as a biphasic poroviscoelastic (saturated)material
  + Integral-type linear viscoelastic model used to describe the constitutive relationship of the collagen-proteoglycan matrix in shear
  + Uncouples the frictional interstitial flow effect from the known intrinsic viscoelastic effect of the collagen-pg matrix
* **A large deformation viscoelastic model for double-network hydrogels**
* **Authors: Mao, Lin, Zhao, Anand**
  + Drawback: did not take into account poroelasticity of hydrogel, did not model final fracture
* **Biphasic Creep and Stress Relaxation of Articular Cartilage in Compression: Theory and Experiments**
* **Authors: Mow, Kuei, Lai and Armstrong**
  + ***Seminal Paper from Mow***
  + Considers viscoelastic dissipation of the solid matrix as well as a viscous dissipation of interstitial fluid
  + Nonlinear permeable biphasic model used to describe the rheological properties of articular cartilage
  + Most important factor governing viscoelastic properties of cartilage in compression
    - Frictional drag of relative motion
* **A microstructurally based continuum model of cartilage viscoelasticity and permeability incorporating measured statistical fiber orientations**
* **Authors: Pierce, Unterberger, Trobin, Ricken, and Holzapfel** 
  + 3D finite strain constitutive model addressing both solid and fluid dependence of the tissue’s mechanical response on the patient-specific collagen fiber network
  + Quasi-static, biphasic model with individually incompressible phases
    - Determine the effects of each independently (Ex. removing fiber network)
  + Inhomogeneity of the orientation of the fiber network through the thickness of the cartilage has a larger effect on the distribution of fluid pressure
  + Drawbacks > cannot capture the effects of osmotic swelling
* **A fibril-reinforced poroviscoelastic swelling model for articular cartilage**
* **Authors: Wilson, van Donkelaar, van Rietbergen, and Huiskes**
  + FPVES: fibril-reinforced poroviscoelastic swelling model
    - Accounts for reaction forces during swelling, confined compression, indentation, and lateral deformation during unconfined compression
* **Stresses in the local collagen network of articular cartilage: a poroviscoelastic fibril-reinforced finite element study**
* **Authors: Wilson: van Donkelaar, van Rietbergen, Ito, and Huiskes**
  + Determine local stresses and strains in collagen fibrils using a poroviscoelastic fibril-reinforced FEA model

**Uncategorized**

* **Minimization and saddle-point principles for the phase-field modeling of fracture in hydrogels**
* **Authors: Boger, Keip, and Miehe**
  + Phase-field model of hydrogel fracture in a variational framework
  + Large volume change > leads to buckling and crack initiation and growth
* **Nonlinear elasticity of biological tissues with statistical fiber orientation**
* **Authors: Federico and Gasser**
  + Fiber orientation can be represented by a probability density function (PDF) defined on the unit sphere
    - PDF provides the probability of finding a fiber oriented in a given direction
  + Modelled the collagen fiber distribution in articular cartilage
    - Articular cartilage is characterized by a location-dependent fiber arrangement that can’t be represented with a finite number of fiber families
  + Does not account for shear interactions between matrix and fibers, fiber networking and entanglement
* **A phase-field approach to model fracture of arterial walls: Theory and finite element analysis**
* **Authors: Gultekin, Dal and Holzapfel** 
  + Invariant-based anisotropic crack phase-field approach
  + Derived regularized crack surface to overcome sharp crack discontinuities
  + Coupled problem solved using one-pass operator-splitting algorithm > mechanical predictor step and crack evolution step
* **A phase-field model for fracture in biological tissues**
* **Authors: Raina and Miehe**
  + Phase-field model equipped with anisotropic crack driving force (thermodynamically consistent)
  + Applicable to both rate dependent or independent brittle and ductile failure modes
  + Advantage to diffusive crack modeling > predicting the complex crack topologies where methods with sharp crack discontinuities suffer

Highly nonlinear stress-relaxation response of articular cartilage in indentation: importance