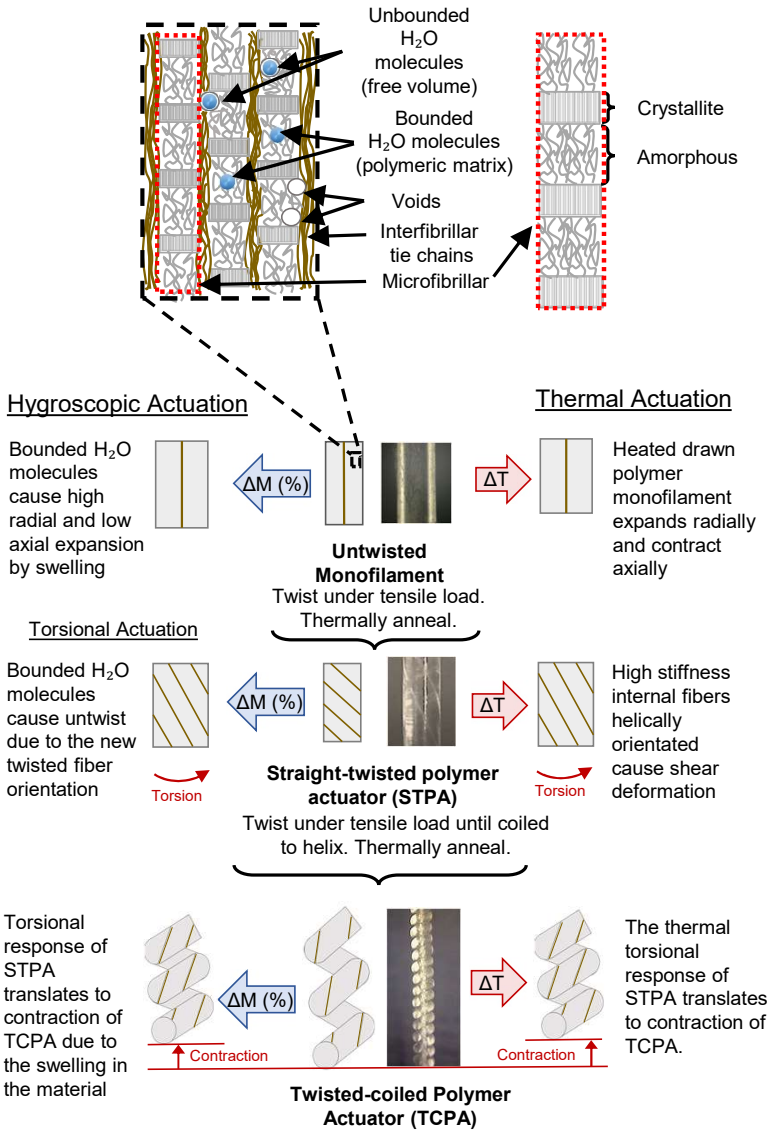
Unbounded H_2O molecules (free volume)
Bounded H_2O molecules (polymeric matrix)
Voids
Interfibrillar tie chains
Microfibrillar
Crystallite
Amorphous
Hygroscopic Actuation
Bounded H_2O molecules cause high radial and low axial expansion by swelling
ΔM (%)
Thermal Actuation
ΔT
Heated drawn polymer monofilament expands radially and contract axially
Untwisted Monofilament
Twist under tensile load. Thermally anneal.
Torsional Actuation
Bounded H_2O molecules cause untwist due to the new twisted fiber orientation
ΔM (%)
ΔT
High stiffness internal fibers helically orientated cause shear deformation
Torsion
Torsion
Straight-twisted polymer actuator (STPA)
Twist under tensile load until coiled to helix. Thermally anneal.
Torsional response of STPA translates to contraction of TCPA due to the swelling in the material
ΔM (%)
ΔT
The thermal torsional response of STPA translates to contraction of TCPA.
Contraction
Contraction
Twisted-coiled Polymer Actuator (TCPA)