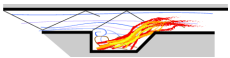
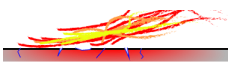
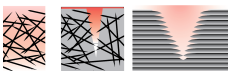
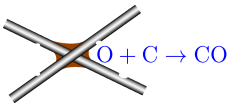
	Physics/Scale	Code(s)	Essential Physics	Anticipated Physics	Potential Physics
Full	 ~ m	*MIRGE-Com* {*Nek5000-DG*} *Cantera* *Prometheus*	Turbulent mixing Shocks Combustion Complex geom.	Radiation Flexible wall Wall texture Wall transpiration	Particle trajectories Radicals
	Needs: Wall conditions T, (maybe Y_i, geom.); **Provides:** Gas T, Y_i, (maybe $\boldsymbol{\sigma}$)				
Macro	 ~ m×cm	*WARP3D* {*RAPtor*}	Thermal conductivity	Fracture Fragmentation Recession Elastic response	Vibration
	Needs: Local mechanical degradation, local Y_O, traction separation prms.; **Provides:** Cracking, regression, failure.				
Meso	 ~ mm	*PuMA* {*Cedar*}	Oxidation Transport	Micro-cracking Recession Detailed porous transport Porous material radiation	Sublimation Evaporation Wetting
	Provides: Thermal conductivity, convective transport, local concentrations, microstructure geometry.				
Micro	 ~ μm	*SPARTA* *WARP3D* {*RAPtor*}	Surface kinetics	Stress-coupled reaction De-bonding	Grain-scale pitting
	Provides: Local surface chemical kinetics.				
Nano	~ nm	*LAMMPS*		Solid-state diff. Traction-separation Phonon–kinetic models	Quantum (DFT) potentials
	Provides: O diffusion, O-dependent traction separation.				