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Multilevel Block Preconditioned Methods for Multi-Domain Quasistatic Thermomechanics

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The source-term for most of the physics in nuclear fuel is the heat generated from nuclear fission and the resulting transmutation (which includes fission) of the materials due to irradiation. The heat, primarily generated in the fuel, is transported through the fuel, across a gap, through a cladding material, and removed by a coolant. The irradiation and temperature change in turn produce a mechanical response in the solid bodies (fuel and cladding). This problem is described by a multi-domain (pellet, gap, and clad) multi-physics (nonlinear thermomechanics) nonlinear system of PDE's. This talk will describe recent work on fully coupled quasistatic nonlinear thermomechanics simulations for this problem. The solution method used is a Jacobian free Newton-Krylov method preconditioned by a block diagonal preconditioner consisting of thermal diffusion and mechanics. The talk will describe the solution process, comparison to experiment, and implementation within a new multi-physics framework being jointly developed by ORNL, LANL, and INL.