JOHNS HOPKINS
WHITING SCHOOL of ENGINEERING

Department of Civil and Systems Engineering

GRADUATE SEMINAR

Mechanics and Rupture of Blood Clots

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Fibrin, a polymeric proteinaceous network, resulting from blood clotting, naturally acts as the mechanical scaffold of hemostatic blood clots and obstructive thrombi. In addition, fibrin-based biomaterials, known as fibrin glues or sealants, are widely used in surgery to prevent bleeding from wounds of various origins. It is critically important that fibrin is mechanically tough and resistant to fracture, as it must withstand forces of blood flow. We have developed an estimate of fibrin toughness by examining the mode-I rupture of macroscopic fibrin plasma clots of millimeter size, in which we inserted edge cracks perpendicular to the axis of extension. We calculated the critical energy release rate from the force-displacement curves of these specimens using the methods of Rivlin and Thomas for rubbers undergoing large deformations and determined it to be on the order of 7.6 J/m^2. Finite element modeling based on fibrin constitutive laws accounting for unfolding of monomers and large volume changes due to loss of water from the clots independently confirmed this critical energy release rate. In a separate set of experiments and models we have characterized the compression behavior of fibrin clots by accounting for micro-buckling of fibers using a double-well energy landscape.

Prashant Purohit is a professor of Mechanical Engineering and Applied Mechanics at the University of Pennsylvania. He got his PhD at Caltech in 2002 and after a few years of postdoctoral work he joined the faculty at Penn in 2006. His interests are in phase transitions, statistical mechanics and biophysics. His current research is focused on the mechanics of blood clots and the mechanics of DNA and lipid membranes.

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