SHOCK11-2011-020033

Abstract for an Invited Paper
for the SHOCK11 Meeting of
the American Physical Society

**Toward Long-Time Simulation of Ballistic Gel Penetration**[1]

ADRIAN LEW, Stanford University

Ballistic gelatin is used as a surrogate for tissue to study the performance of armor and ammunition. Numerical simulations of impact and penetration of ammunition into ballistic gelatin have the potential to complement experimental work. Ballistic gelatin is a nearly incompressible material with viscoelastic features, which can recover from very large strains. As a result, a bullet penetrating the gel forms a large temporary cavity behind it, which at long times collapses to a very small one. This is a marked difference with the behavior of a fluid under similar circumstances. This poses strenuous challenges to current numerical tools, since an imperfect "memory" of the material elasticity leads to abnormally large remaining cavities. Reaching these later times in a simulation ($\sim$10 ms) is challenging to do in a reasonable time frame of a few hours. In this presentation I will first showcase the phenomena we are trying to capture through experiments in Permagel. Among others, these show the bullet rebounding after fully stopping, the importance of the gases inside the created cavity in its long-term dynamics, and the apparent appearance of mild plastic deformations and local melting in the gel. I will then discuss about the numerical tools we are creating to simulate it. I will show a suite of variational time-integration strategies able to reach long-time simulations with reasonable accuracy. Then, I will comment on novel automatic remeshing strategies we are creating, needed to simulate the large shear deformations in the gel while retaining accurate elastic recoveries. I will illustrate these ideas with simulations in highly parallel computing environments, and discuss the challenges we face to qualitatively recover a number of the experimental observations.

[1]Department of the Army Research Grant; contract/grant number: W911NF-07-2-0027.