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3D Printed Shock Mitigating Structures AMANDA SCHRAND, AFRL, EDWIN ELSTON, University of Dayton Research Institute, MITZI DENNIS, University of Florida, TAMMY METROKE, CHENGGANG CHEN, STEVEN PATTON, University of Dayton Research Institute, SABYASACHI GANGULI, AJIT ROY, AFRL — Here we explore the durability, and shock mitigating potential, of solid and cellular 3D printed polymers and conductive inks under high strain rate, compressive shock wave and high g acceleration conditions. Our initial designs include a simple circuit with 4 resistors embedded into circular discs and a complex cylindrical gyroid shape. A novel ink consisting of silver-coated carbon black nanoparticles in a thermoplastic polyurethane was used as the trace material. One version of the disc structural design has the advantage of allowing disassembly after testing for direct failure analysis. After increasing impacts, printed and traditionally potted circuits were examined for functionality. Additionally, in the open disc design, trace cracking and delamination of resistors were able to be observed. In a parallel study, we examined the shock mitigating behavior of 3D printed cellular gyroid structures on a Split Hopkinson Pressure Bar (SHPB). We explored alterations to the classic SHPB setup for testing the low impedance, cellular samples to most accurately reflect the stress state inside the sample (strain rates from 700 to 1750 s-1). We discovered that the gyroid can effectively absorb the impact of the test resulting in crushing the structure. Future studies aim to tailor the unit cell dimensions for certain frequencies, increase print accuracy and optimize material compositions for conductivity and adhesion to manufacture more durable devices.

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