Title: Mapping cold spray adhesion windows using single particle impact data

Authors: Jasper Lienhard[a], Keith A. Nelson[b], Christopher A. Schuh[a]
[a] Department of Materials Science and Engineering, MIT, Cambridge, MA 02139, USA
[b] Department of Chemistry, MIT, Cambridge, MA 02139, USA

The laser-induced particle impact test (LIPIT) can be used to impact individual metal microparticles onto metal substrates at controlled impact velocities. This technique, which enables in-situ observation of particle deformation during impact, is useful for studying the physical processes that control cold spray adhesion. Here we present several sets of microparticle impact data collected with LIPIT that demonstrate the wide range of particle and substrate behaviors that can occur during impact including jetting, adhesion, melting, particle fragmentation, hydrodynamic penetration, and erosion. We use this data to map the processes that control the upper and lower bounds of the cold spray velocity adhesion window and to examine how various behavior transition points differ between different metals. Using scanning electron microscopy and laser scanning confocal microscopy, we conduct post-mortem characterization on dozens of individually impacted particles with known impact velocities, and we measure how the net volume of particle material deposited changes with increasing velocity. We found that unlike the processes that control adhesion at the critical adhesion velocity, the upper bound erosion mechanism differs dramatically between different metals.