Magnetic Pulse Welding of Tubular Parts

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Abstract.
Magnetic Pulse Welding (MPW) enables to join metals with very low heat input, compared to conventional fusion welding technologies. Thus, dissimilar material combinations are producible without the formation of critical intermetallic phases. The process consists of two stages, an electromagnetically driven forming process and the controlled high-speed collision with the joining partner. Adjusting the time-depended magnetic field distribution along the part's surface is key to achieve proper collision conditions and to generate a sound solid state weld.
MPW is preferably applied to join axisymmetric parts since the usual shape of a coil results in strong compressive forces on the electrically conductive tube when it is placed in the center of the working coil. Field shapers are often applied to intensify the magnetic field of the coil and to ensure a sufficient acceleration of the work piece. The position of the field shaper's slot is of special interest during process adjustment, since the magnetic field shows inhomogeneities that can lead to collision conditions outside of the "welding window". Furthermore, geometrical disturbances of the parts, such as variations in roundness, wall thickness and joining gap affect the forming behavior of the tube and correspondingly the collision behavior. In this paper, the influence of the mentioned disturbance variables on the welding result is studied both experimentally and numerically. Photon Doppler Velocimetry is used to monitor the acceleration and collision phase of the tube during the experiments. Additionally, the impact flash spewing out of the joining gap is recorded and evaluated. With this innovative measurement method, not only geometrical deviations are detectable, but also surface properties and contaminations that might hinder weld formation. The targeted manipulation of the MPW process highlights the ranges of certain disturbance values that must not be exceeded during production of a generic aluminum-steel assembly.