Characterizing Multi-Pass Conditions for Roll Bonding of Aluminum Alloys

A. Krämer[1), a)], Z. Liu[1)], K. Karhausen[2), b)], H. Aretz[2)], M. Teller[1)], G. Hirt[1)]

[1]Institute of Metal Forming (IBF), RWTH Aachen University, Intzestr. 10, 52072 Aachen, Germany
[2]Hydro Aluminium Rolled Products GmbH, Georg-von-Boeselager-Str. 21, 53117 Bonn, Germany
[a)]Corresponding author: kraemer@ibf.rwth-aachen.de
[b)]kai-friedrich.karhausen@hydro.com

Abstract. Roll bonding is one of the most prevalent industrial processes to produce permanently joined metal products. Especially aluminum is often roll bonded for automobile or aerospace applications due to its low density and high corrosion resistance. During roll bonding, two or more layers of different materials are stacked and joined during several rolling passes. In the case of aluminum, the deformation in the roll gap leads to a fracture of oxide and film-layers enabling virgin metal-metal contact resulting in a firm permanent bond. However, the industrial process consists of multiple passes and corresponding inter-pass times. Since the bond forms in the first passes and persists throughout the process, it is subjected to multiple deformations and waiting periods during inter-pass times. Therefore, an investigation of the influence of multi-pass conditions that enable microstructural changes, such as diffusion and recrystallization, on the bond strength is necessary. This paper hence investigates the observed bond strength as a function of waiting periods and multiple deformations. To conduct the experiments, a plastometer is used, employing two opposing samples with the same geometry made of the two aluminum alloys to be bonded. This setup enables the bond formation and subsequent characterization of bond failure in one experiment while allowing precise control of the deformation conditions, such as temperature and deformation, which can accurately resemble conditions during the industrial process. The results show that inter-pass times can lead to an increased bond strength especially when coupled with annealing. Multiple deformations generally lead to a lower bond strength compared to a single deformation of the same overall height reduction. Therefore, the whole pass schedule contributes to the final bond properties and their evolution. This insight can ultimately help to improve existing or open new production routes in the future.