

Friction Stir Spot Welding of Advanced High-Strength Steel

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Friction stir spot welding (FSSW) is a novel variant of the “linear” friction stir welding (FSW) process, and creates a spot, lap-weld without bulk melting, as illustrated in Figure 1. FSSW of aluminum has been implemented in automotive manufacturing production, and demonstrated cost savings and higher quality compared to resistance spot welding. In this study, an exploratory study was conducted to investigate the feasibility of friction stir spot welding advanced high-strength steel sheet metals. The fixed pin approach was used to weld two different types of steel - 780MPa dual phase steel and 1500MPa hot-stamped boron steel. A single tool, made of polycrystalline cubic boron nitride as shown in Figure 2, survived over one hundred welding trials without noticeable degradation or wear. Solid-state metallurgical bonding was produced with welding time in the range of 2 to 10 seconds, although the bonding ligament width was relatively small. Lap shear strength of 8-12 kN were produced (as shown in Figure 3). The microstructures and hardness variations of a hot-stamped boron steel specimen were illustrated in Figure 4 and will be presented in more details.

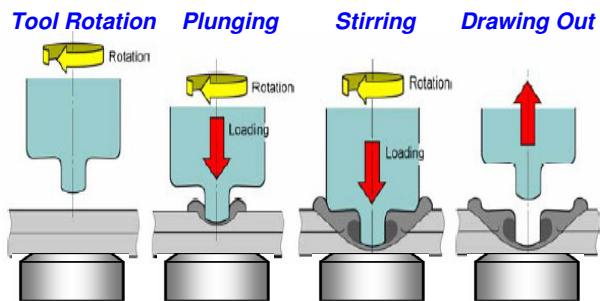


Figure 1: Illustration of Friction stir spot welding (FSSW) process and joining mechanism

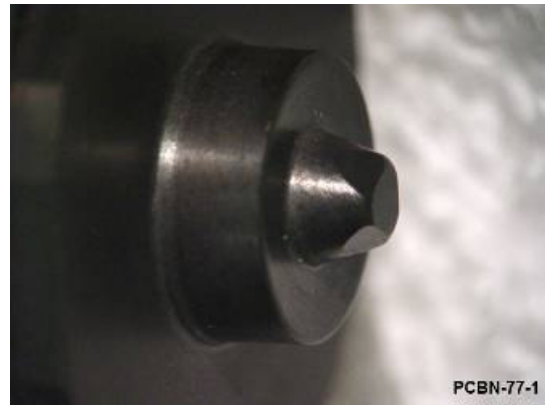


Figure 2: Polycrystalline cubic boron nitride (PCBN) tool used in this study. It has a shoulder diameter of 10 mm, pin length of 2.3 mm and 3 flats on the pin.

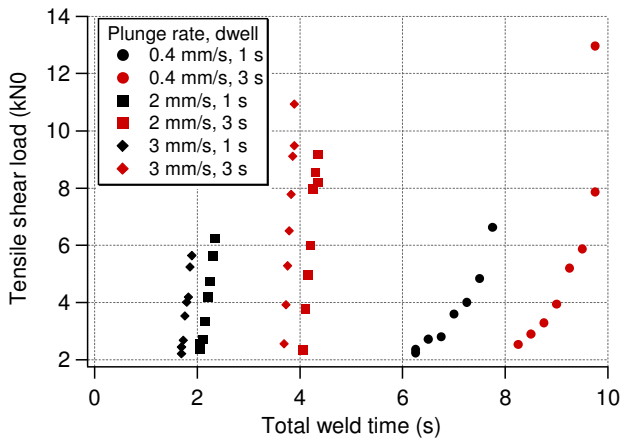


Figure 3: Variation of lap-shear failure load with weld time, at 800 rpm, for DP780.

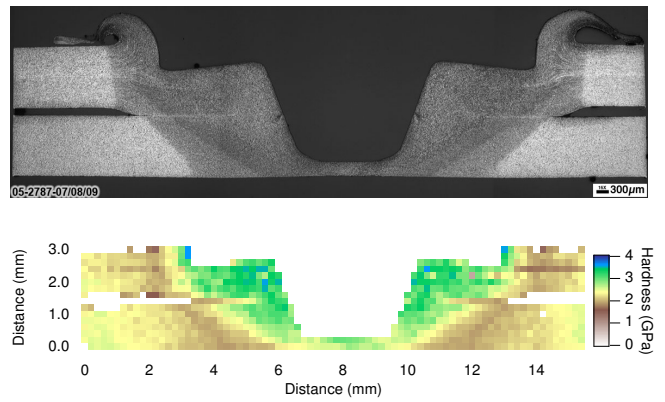


Figure 4: Cross-section micrograph and microhardness profile of FSSW hot-stamped boron steel welded at 800 rpm and 9.75 sec.