Basic Characteristics of Synchronized Stir Welding and Its Prospects

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Abstract : Friction stir welding (FSW) has been widely used in the automotive, aerospace, and high-tech industries due to its superiority in mechanical properties after joining. In order to achieve a good quality joint by friction stir welding (FSW), it is necessary to secure an advanced angle (usually 3 to 5 degrees) using a dedicated FSW machine and to join on a highly rigid machine. On the other hand, although recently, a new combined machine that combines the cutting function of a conventional machining center with the FSW function has appeared on the market, its joining process window is small, so joining defects easily occur, and it lacks reproducibility, which limits its application to the automotive industry, where control accuracy is required. This has limited the use of FSW machines in the automotive industry, where control accuracy is required. FSW-only machines or hybrid equipment that combines FSW and cutting machines require high capital investment costs, which is one of the reasons why FSW itself has not penetrated the market. Synchronized stir welding, a next-generation joining technology developed by our company, requires no tilt angle and is a very cost-effective method of welding. It is a next-generation joining technology that does not require a tilt angle, does not require a complicated spindle mechanism, and minimizes the load and vibration on the spindle, temperature during joining, and shoulder diameter, thereby enabling a wide range of joining conditions and high-strength, high-speed joining with no joining defects. In synchronized stir welding, the tip of the joining tool is "driven by microwaves" in both the rotational and vertical directions of the tool. The tool is synchronized and stirred in the direction and at the speed required by the material to be stirred in response to the movement required by the material to be welded, enabling welding that exceeds conventional concepts. Conventional FSW is passively stirred by an external driving force, resulting in low joining speeds and high heat input due to the need for a large shoulder diameter. In contrast, SSW is characterized by the fact that materials are actively stirred in synchronization with the direction and speed in which they are to be stirred, resulting in a high joining speed and a small shoulder diameter, which allows joining to be completed with low heat input. The advantages of synchronized stir welding technology in terms of basic mechanical properties are described. The superiority of the basic mechanical properties of SSW over FSW was evaluated as a comparison of the strength of the joint cross section in the comparison between FSW and SSW. SSW, compared to FSW, has tensile strength; base metal 242 MPa/217 MPa after FSW 89%, base metal 242 MPa/225 MPa after SSW 93%. Vickers hardness; base metal 75.0HV/FSW; 57.5HV 76% SSW; 66.0HV 88% (weld center), showing excellent results. In the tensile test, the material used was aluminum (A5052-H112) plate 5 mm thick, and the specimen was dumbbell-shaped, 2 mm thick, 4 mm wide, and 60 mm long. Measurements were made at a loading speed of 20%/min (in accordance with Z 2241:2022). Tensile testing machine: INSTRON Japan, model: INSTRON 5982. Vickers hardness was measured on a 5 mm thick specimen of A5052 tempered H112 with a width of 15 mm at 0.3 pitch (in accordance with JIS Z 2244:2020). Vickers tester: FUTURE-TECH Model: FM-300.

Keywords : FSW, SSW, synchronized stir welding, requires no tilt angles, running peak temperature less than 100 degrees C
Conference Title : ICFSWP 2024 : International Conference on Friction Stir Welding and Processing
Conference Location : Riga, Latvia
Conference Dates : June 20-21, 2024