Analysis of Extruded Pins Manufactured by Friction Stir Forming for multi-material joining purposes

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Abstract. Nowadays the application of multi-material parts has become a standard in several sectors, such as in transportation where the use of dissimilar material contributes to reduce the weight of structural components, as well as to decrease fuel consumption and CO_2 emissions [1]. The scientific literature proposes various methods for combining dissimilar materials [2–4], but when there are too incompatible, the process becomes a real challenge [5].

To this aim and to propose an alternative joining technique, which does not require the use of additional external parts, the authors investigated a method based on the Friction Stir Forming (FSF) technology [6]. FSF is a process, where a rotating tool moves on a metal sheet pushing the material through the holes of a forming die positioned under the worked sheet.

In the current study, the authors aimed at improving the quality of the Aluminum extruded pins, which leads to the improvement of the connection with composite materials. To this aim, a specific equipment has been manufactured and installed on a general purpose milling machine (Figure 1) and an experimental plan has been designed. Both process parameters (i.e. spindle speed, forming velocity, etc) and geometrical parametners (i.e. hole diameter and the distance between the holes) have been considered.

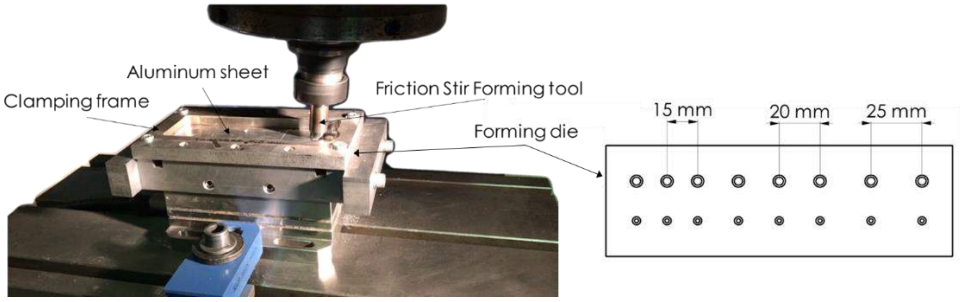

Figure 1. FSF equipment

A deep analysis has been carried out on the extruded Aluminum pins in terms of internal structure and mechanical behavior. An x-ray micro-tomographic analysis has been performed to investigate, qualitatively and quantitatively, the distribution of the material within the manufactured pins. The percentage of voids has been measured by a specific tool and the authors aimed at understanding its influence on the pin strength. Therefore, shear stress measurements have been performed for each single pin.

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