Effects of machining and heat treatment on the fatigue properties of Maraging steel MS1 produced by DMLS

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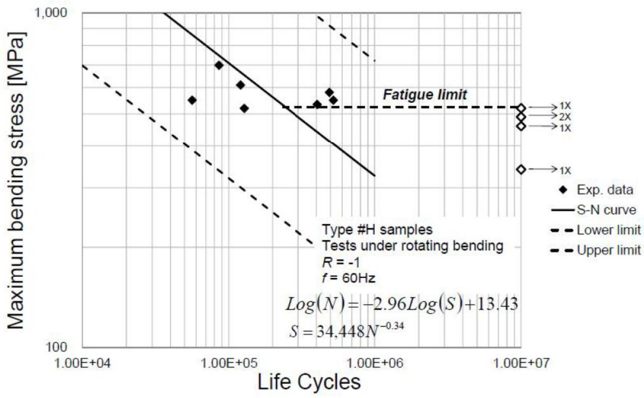
Additive Manufacturing (AM) could revolutionize many fields of manufacturing, from mechanical and industrial engineering to even civil constructions and biomechanics. This novel technology has great potentials, as it enables fast construction of complexly shaped parts in a short time, directly converting a CAD 3D model.



The additive technology of course has also some drawbacks: in particular, the high cost of material powder and the generation of significant tensile residual stresses during the process. These require suitable heat treatments, to achieve their partial release. A further problem arises from the imperfections that may be induced by the scanning process, such as porosities, voids, inclusions and high surface roughness. Micro shot-peening is usually performed to reduce porosities and to introduce compressive residual stresses that counterbalance tensile ones. Parts are then machined to achieve a better surface finishing. However, there is an increasing interest towards the mechanical response of parts in the as fabricated state. Being able to manage these properties without the need for machining or heat treatment would strongly increase the great potentials of this technology in many fields of engineering. This study follows a previous one, dealing with the effect of the build orientation on the fatigue response of Maraging Steel MS1. In that study samples built along three different directions had been considered, moreover, all the samples had been machined (0.5 mm allowance) and heat treated. The present study deals with the effect of machining and heat treatment on the fatigue response of DMLS Maraging steel parts. Specimens have been manufactured according to ISO 1143 for fatigue tests under rotating bending to be loaded under four-point bending. The experimental campaign has been arranged as a 2 by 2 factorial plane, with fixed vertical build orientation. Two levels for machining, as built samples and machining with 0.5mm allowance, have been considered. The heat treatment has also been studied over two levels: no treatment and aging at the temperature of 490°C (for 6 hours), as recommended by the material supplier.

The plan consists of four treatment combinations, with the fourth one being provided by the aforementioned previous study. The first results (Fig. 1), involving unmachined heat treated samples, indicate that the fatigue limit (26% of the ultimate strength) is approximately 13% decreased with respect to that of the machined ones. Moreover, the fatigue curve is much steeper and more scattered. The worse performance and scattering are likely to arise from high roughness, being one order of magnitude higher with respect to machined samples.

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