

# **Influence of Microstructural Characteristics on Electrical Discharge Wire Cutting Conditions of A390 Al-Si Hypereutectic Alloy**

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## **ABSTRACT**

Electrical discharge wire cutting (EDWC) is a spark erosion process used to produce complex two-and three dimensional shapes through electrically conductive workpieces. Newer and more exotic materials created and/or demanded by space technology sometimes cannot be economically cut using conventional cutting tools, but cut effectively by EDWC. The process wastes very little workpiece material due to its small kerf size, coupled with the fact that the process can accurately cut unusual shapes. In modern manufacturing industry, EDWC has been extensively used to machine complicated shapes on advanced materials with high accuracy.

This paper presents the result of an experimental investigation on the machinability of A390 hypereutectic Al-Si alloy using wire electrical discharge machine. The effect of the modification and grain refinement treatments on the microstructure on the machining conditions was evaluated. The process parameters taken into consideration are the average gap voltage, surface finish type, pulse frequency, cutting speed, material removal rate, and kerf size.

## **KEYWORDS**

Electrical discharge wire cutting (EDWC), Al-Si hypereutectic alloys, material removal rate, cutting speed, surface roughness.

## **1. Introduction**

Hypereutectic alloys such as A390 exhibits several very specific and interesting properties, such as high wear resistance, high strength and hardness, and low thermal expansion coefficients [1]. As a result, they are used in heavy wear applications, often at elevated or medium temperatures, such as in pistons, cylinder blocks and AC compressors. Unfortunately, the machinability of these alloys is poor, because the extreme hardness of the silicon combined with the relative softness of the matrix tends to wear the tool very rapidly [2].

In Al-Si alloys, the eutectic phase usually has an irregular shape because silicon is a faceted phase. Many efforts have been made in the microstructural modification of casting Al-Si alloys in order to achieve fine Si phases with beneficial shapes and distributions. For instance, by adding Na and Sr or with a cooling rate exceeding approximately 5 °C/s, the eutectic is changed from the flake to a fibrous appearance. Eutectic modification is carried out to improve mechanical properties and also the machinability of Al-Si alloys [3]. Another treatment is carried out on aluminum alloys which known as grain refinement. Grain refinement has been an important technique for improving the soundness of aluminum products [4]. The addition of the grain refiners, usually master alloys containing potent nucleant particles promotes formation of a fine equiaxed macrostructure by suppressing the