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Short Communication

Mechanical and anisotropic behaviors of 7075 aluminum alloy sheets

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ABSTRACT

Formability of 7075 aluminum alloy sheets was studied after annealing of 71% cold worked (CW) samples at different temperatures (270–450 °C). Uniaxial tensile test, deep drawing and Erichsen test were carried out at room temperature to evaluate formability parameters.

Average plastic strain ratio, planar anisotropy, and work hardening exponent of samples were calculated from the tensile test data. The tensile properties and formability parameters were correlated with the limit drawing ratio (LDR) and Erichsen test. It was found that the sheets annealed at 400 °C possess good ductility, high average *n*-value and the normal anisotropy *r*-value so that, the formability of 7075 aluminum alloy can be improved by increasing annealing temperatures to the 350–400 °C.

1. Introduction

The 7xxx series aluminum alloys have been widely used as structural materials due to their attractive comprehensive properties, such as low density, high strength, ductility, toughness and resistance to fatigue [1–3]. The 7075 aluminum alloy is one of the most important engineering alloys. It has been utilized extensively in aircraft construction due to its high strength-to-density ratio [4].

High strength alloys are desirable to reduce the weight and cost for constructional applications. In addition, good ductility is also required for formability. However, the enhancement of the strength of a material while maintaining reasonable ductility is a permanent challenge [5]. By recrystallization, there is a gradual decrease in the tensile strength (UTS), yield strength (YS) and hardness. It also increases the elongation of the rolled material by increasing annealing temperature. The formability of sheet metal is an important parameter of the manufacturing process design.

Thin sheet products are obtained by cold rolling and subsequent annealing treatment that affects forming behavior. Metals, that have undergone extensive plastic deformation by rolling or extrusion, exhibit a significant anisotropy of mechanical properties. Even in the case of untextured metals showing isotropic or almost isotropic yielding behavior, the ductility can be very anisotropic [6]. Recently, research on aluminum alloy are focused on mechanical properties, texture and anisotropic behavior that give rise from processing of aluminum alloy sheet especially cold rolling and annealing [5,7–10]. It was found that the formability of 5052 aluminum alloy annealed at 350 °C possessed good formability, optimal texture and high normal anisotropy value [9]. The formability is also dependent on the material properties such as strain hardening exponent (n), strain rate sensitivity (m), and grain size [11–14].

The 7075 aluminum alloy plate, in O temper condition, have practical and industrial application due to their higher formability in comparison to the other temper conditions. There has been little research on formability and anisotropic behavior of 7075 aluminum alloy. At present study, in order to examine the possibility of the practical use of 7075 aluminum alloy, the mechanical properties, anisotropic behavior and formability of 7075 aluminum alloy thin sheet at various annealing temperatures were investigated.

2. Materials and experimental procedures

2.1. Research material

A7075 O-temper aluminum alloy plate was supplied in 7.2 mm thickness for research. The chemical composition of 7075 aluminum alloy is given in Table 1. For deep drawing test, thickness of plate was reduced to 3.9 mm by remove material. The 7075 aluminum alloy plate, in O temper condition, was selected as the starting material (SM) in this investigation.

2.2. Cold rolling and annealing

Cold rolling of the 7075 Al alloy was carried out by rolling plates with various thicknesses according to mechanical testing: (a) thickness of 7.2 mm to 2.1 mm equal to 71% CW for tensile properties; (b) thickness of 3.9 mm to 1.1 mm equal to 71% CW for deep drawing and Erichsen tests. The cold-rolled samples were annealed at various temperatures in the range of 270–450 °C for 5 min. A programmable Nabertherm furnace was used for annealing; and

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