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Design and Development of High Strength Aluminium Alloy from Recycled 7xxx-Series Material Using Bayesian Optimisation

Authors : Alireza Vahid, Santu Rana, Sunil Gupta, Pratibha Vellanki, Svetha Venkatesh, Thomas Dorin

Abstract : Aluminum is the preferred material for lightweight applications and its alloys are constantly improving. The high strength 7xxx alloys have been extensively used for structural components in aerospace and automobile industries for the past 50 years. In the next decade, a great number of airplanes will be retired, providing an obvious source of valuable used metals and great demand for cost-effective methods to re-use these alloys. The design of proper aerospace alloys is primarily based on optimizing strength and ductility, both of which can be improved by controlling the additional alloying elements as well as heat treatment conditions. In this project, we explore the design of high-performance alloys with 7xxx as a base material. These designed alloys have to be optimized and improved to compare with modern 7xxx-series alloys and to remain competitive for aircraft manufacturing. Aerospace alloys are extremely complex with multiple alloying elements and numerous processing steps making optimization often intensive and costly. In the present study, we used Bayesian optimization algorithm, a well-known adaptive design strategy, to optimize this multi-variable system. An Al alloy was proposed and the relevant heat treatment schedules were optimized, using the tensile yield strength as the output to maximize. The designed alloy has a maximum yield strength and ultimate tensile strength of more than 730 and 760 MPa, respectively, and is thus comparable to the modern high strength 7xxx-series alloys. The microstructure of this alloy is characterized by electron microscopy, indicating that the increased strength of the alloy is due to the presence of a high number density of refined precipitates.

Keywords : aluminum alloys, Bayesian optimization, heat treatment, tensile properties
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