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A REVIEW ON THE MECHANICAL PERFORMANCE OF SUPERALLOYS

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ABSTRACT

Superalloys are unique high temperature materials which display excellent mechanical properties. Most importantly, these materials possess a remarkable ability to maintain their performances and even improve it further at elevated temperatures. The ability to withstand loading at an operating temperature close to its melting point, a substantial resistance to mechanical degradation over extended periods of time and tolerance to severe operating environments made superalloys outstanding candidates for various niche applications. They are primarily used as the components of turbines, rockets and heat exchangers. For such applications, the performances are restricted by the operating conditions which need to be tolerated by the materials. When significant resistance to loading under static, fatigue and creep conditions is required at high temperature, the nickel-base superalloy is the material of choice. This category of superalloy is utilized particularly beyond 800□C in gas turbines used for jet propulsion. The review also discusses the superiority of superalloys over other competitive alloys such as Ti-based alloys and intermetallics. Primarily, this review aims to provide the overview and justification for the selection of materials for high temperature applications which can withstand considerable loads for extended periods of time. The performance of first, second and third-generation single-crystal superalloys which are used for the turbine blades of modern aero-engines, a polycrystalline superalloy named Waspaloy used for the turbine discs required to house the blading, an oxide-dispersion-strengthened superalloy MA754 made by powder metallurgy are explored. The failure of components manufactured from the superalloys is also analyzed extensively. The review attempts to present future needs of alloy and process development which can improve the performance of superalloys.

Keywords: Superalloys, high-temperature materials, gas turbine