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Mechanical and thermophysical properties of high-temperature Ir_xRe_{1-x} alloys

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ABSTRACT

The Ir_xRe_{1-x} ($0.1 \leq x \leq 0.7$) alloys are hexagonal structured inclusion material used in an on-orbit communication satellite. The characteristic features of high-temperature alloys Ir_xRe_{1-x} ($0.1 \leq x \leq 0.7$) are investigated by the theoretical evaluation of thermophysical and ultrasonic properties at room temperature. Initially, higher-order elastic constants of the alloys are calculated using the simple interaction potential model approach. With the help of this other elastic moduli, elastic stiffness constants and hardness parameters are estimated at room temperature for elastic and mechanical characterization. Later on, the ultrasonic velocity and thermal relaxation time of chosen alloys are evaluated utilizing calculated values of SOECs and lattice parameters within the same physical conditions. The orientation-dependent ultrasonic velocities and thermal relaxation time have been also evaluated for the determination of anisotropic behaviour and thermophysical properties. The obtained results are analysed to explore the inherent properties of Ir_xRe_{1-x} alloys.

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High-temperature alloys; IrRe; elastic properties; ultrasonic velocity; thermal relaxation time

1. Introduction

The compelling demand of materials' sustained use at temperature greater than about 1500 °C, there are challenging tasks for material-scientists and engineers to develop high-temperature materials [1,2]. The high-temperature alloys paved the way to overcome this difficulty. Such types of alloys have very high melting point and exhibit improved resistance to oxidation at higher temperature regime [3]. These alloys are used to manufacture flight-type rockets, turbine blades and other components of jet engine. Unfortunately, the materials that have higher melting points are rapidly oxidized in the environments. Iridium (Ir) has very high melting point (2454 °C), so it is the most promising material for applications in high-temperature environments [4]. Iridium is a quite expensive element compared with other elements used in high-temperature applications. The incorporation of rhenium (Re) into iridium-containing alloys overcomes this difficulty because Re has also a higher melting point like Ir, but generally Re is less expensive than Ir. Iridium-rhenium (IrRe) alloys are very economical and used to make thruster chamber in an on-orbit communication satellite. These alloys demonstrate the excellent reliability and compatibility in a high-temperature oxidizing environment [4–10].

For any cast restoration to be successful, the fundamental aspects such as mechanical deformation and structural stability of the materials must be understood. Elastic constants of materials play a vital role in describing their structural stability and mechanical deformation under the action of external loading condition [11]. The linear elastic properties of the materials can be understood with the

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