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Thermodynamic assessment of the Al-Re system

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The Ni-based superalloys possess remarkable ability to maintain their interesting properties at high temperatures and are developed for specialized applications like turbines, rockets and heat exchangers [1]. In order to improve the creep and fatigue behavior of Ni-based superalloys, rhenium is one of the important elements added to theses alloys [2, 3].

Knowledge of phase diagram and thermochemical properties of the Al-Re system is important for understanding the phase equilibria between Al and Re and designing materials with desired properties.

Several authors studied the Al-Re binary diagram experimentally [4-7]. Comparison of already determined phase diagrams shows that they are in clear contradiction [8]. The experimental difficulties are dues to the complex relation ships between phases and to the very large difference between the elemental melting points which make difficult the specimen preparation, especially since aluminum has a high partial pressure. On the other hand, the large difference of the atomic number between the component elements compromises the accuracy of EDS quantitative analyses.

The objective of this work is to develop a thermodynamic description of the Al-Re binary system based on fragmentary experimental phase diagrams and thermodynamic data available in the literature. This assessment may be used as a base for building a thermodynamic database for higher order systems. The Calphad-Thermocalc [9] approach was used to optimize and analysis the Al-Re binary system. Solution phases including Liquid, fcc and hcp were described with a substitutional model, of which the excess Gibbs energies were formulated with the Redlich-Kister polynomial. Binary intermetallic phases were treated as stoichiometric compounds. The results of comparisons between the calculated and experimental phase diagrams as well as thermodynamic quantities available in the literature are discussed.

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