IOWA STATE UNIVERSITY

Materials Science & Engineering Department

Alexander Spicher

Final Oral Examination
MS Student with Iver Anderson

Friday, May 16 · 9:00 AM · 301B Spedding Hall

"Effects of aluminum additions to gas atomized reaction synthesis produced oxide dispersion strengthened alloys"

The production of an aluminum containing ferritic oxide dispersion strengthened (ODS) alloy was investigated. The production method used in this study was gas atomization reaction synthesis (GARS). GARS was chosen over the previously commercial method of mechanical alloying (MA) process due to complications from this process. The alloy compositions was determined from three main components; corrosion resistance, dispersoid formation, and additional elements. A combination of Cr and Al were necessary in order to create a protective oxide in the steam atmosphere that the boiler tubing in the next generation of coal-fired power plants would be exposed to. Hf and Y were chosen as dispersoid forming elements due to their increased thermal stability and potential to avoid decreased strength caused by additions of Al to traditional ODS materials. W was used as an additive due to benefits as a strengthener as well as its benefits for creep rupture time.

The final composition chosen for the alloy was Fe-16Cr-12Al-0.9W-0.25Hf-0.2Y at%. The aforementioned alloy was created through gas atomization with atomization gas of Ar-300ppm O2. An additional alloy that was nominally the same without the inclusion of aluminum was created as a comparison for the effects on mechanical and corrosion properties. An investigation on the processing parameters for these alloys was conducted on the aluminum containing alloy. In order to predict the necessary amount of time for heat treatment, a diffusion study was used to find the diffusion rate of oxygen in cast alloys with similar composition. The effect of heat treatment time was investigated with temperatures of 950°C, 1000°C, 1100°C, and 1200°C. The heat treatment was evaluated through factors such as microhardness analysis, SEM imaging, and x-ray diffraction. Both alloys were rolled to 70% reduction in thickness and evaluated through microhardness, tensile testing, and corrosion testing. Tensile testing was performed at elevated temperatures in order to determine viability during operation in coal fired power plants. Two corrosive atmospheres were investigated: 1200°C air and 1100°C air with 10 vol% water. These alloys were compared to previously available commercial ODS alloys such as PM2000 and MA956.