Rare-earth Information Center Insight

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Rare Earth Mineral Industry Surveys

The U.S. Geological Survey, U.S. Department of Interior, has recently released the 1996 Annual Review of Rare Earths. This review is authored by J. B. Hedrick, Rare Earth Commodity Specialist. These reports are familiar to many in the rare earth community though until recently they were issued by the Bureau of Mines, which no longer exists. As in previous years, the sole U.S. domestic mine is Molycorp's Mountain Pass, California mine, which produced 20,400 tons REO in 1996, a decrease of 1,800 tons from the 1995 level. Molycorp Corporation, Rhône-Poulenc, and W. R. Grace & Co. all produce refined lanthanides in the U.S. The report, which in addition to production covers U.S. consumption, tariffs, prices, foreign trade and a world review, is available from http://minerals.er.usgs.gov/pubs/commodity/rare_earths/. The FaxBack number is (703) 648-4999. Fax requests to (703) 648-7722 or call (703) 648-7725.

Atomic Weights

In case you missed the IUPAC report "Atomic Weight of the Elements 1995" {*Pure Appl. Chem.*, **68**, 2339 (1996)}, it has been reprinted {*J. Phys. Chem. Ref. Data,* **26**, 1239-53 (1997)}. Sc, Ce, Pr, Eu, Tb, Ho and Tm are all included in the list of elements, whose atomic weights have been revised. In each case, the change is a reduction of uncertainty in the atomic weight as higher precision mass determinations become available. This is not the case for some of the other elements, where changes reflect new data on isotopic abundance. The report includes historical data on the atomic weights of the elements, providing an interesting glimpse of the progress in science.

Aluminum Alloys

Two recent reports deal with Sc and rare earth additions to aluminum alloys. Kramer et al. {*Adv. Mater. & Processes*, **152**, 23-4 (1997)} report on the addition of Sc, which acts as a potent dispersoid-strengthener, grain refiner and recrystallization inhibitor. The Sc forms Al_3Sc, which while coherent with the Al matrix, exhibits a lattice mismatch of 1.2%. This mismatch results in high strains, which block dislocation motion and impede grain growth. In addition, Sc can be used to increase the recrystallization temperature of Al alloys to above 600°C, allowing precipitation hardened aluminum alloys to be solution heat treated below their recrsytallization temperature, which eliminates the loss of strength that may be associated with recrsytallization. The effect of Sc can be further enhanced by partial substitution of Zr for Sc to form $Al_3(Zr_xSc_{1-x})$. The Sc modifications of welding filler alloys was shown to reduce hot cracking in Seville alloys.

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L. Meng and X. L. Zheng have published an overview of rare earth element and impurity effects in Al-Li alloys {*Mater Sci. & Eng.*, **A237**, 109-18 (1997)}. Al-Li are 8% lighter than conventional Al alloys, but due to their high specific stiffness (modulus/density), a 24% weight savings could be realized in aerospace structures. However, these alloys have poor ductility, low fracture toughness and high anisotropy in mechanical properties when compared to conventional Al alloys. The Al-Li alloys are particularly sensitive to impurities, which embritttle the alloys. The addition of rare earth elements results in the refining out of impurities and the reduction in the grain size of cast grains during melting processes. As discussed above for Sc in conventional alloys, they delay recrystallization and refine precipitates during heat-treating.

W-La_2O_3

In order for tungsten to exhibit high temperature creep resistance, it is necessary to inhibit grain growth at elevated temperatures. This is typically done by small alloying additions of Al, K and Si, which create arrays of bubbles. With proper processing, these arrays can cause the W to form long aligned grains. A similar effect has been achieved with ThO_2 additions. The natural level of radiation in Th creates a problem in handling the material, even if it is only in the documentation of safety precautions. Mabuchi et al. {*Mater. Sci. & Eng.*, **A237**, 241-9 (1997)} have reported on the use of La_2O_3. In as-rolled sheet, the W-La_2O_3 showed almost the same strength as pure W. In the annealed state, the alloyed material exhibited enhanced strength. At the current time, the authors feel that the explanation of the enhanced strength is not sufficiently well understood.

The Evolution of Microstructure During the Solidification of Peritectic and Other Complex Alloys

The Center for Rare Earths and Magnets (CREM) has successfully completed the first phase of the competition for a National Science Foundation (NSF) Materials Research Science and Engineering Center (MRSEC). In the first phase, a preproposal by R. W. McCallum, R. K. Trivedi, M. J. Kramer, A. K. Mitra (Iowa State University), A. Karma (Northeastern University) and J. H. Perepezko (University of Wisconsin, Madison) resulted in an invitation to submit a full proposal. The proposal is entitled "The Evolution of Microstructure During the Solidification of Peritectic and Other Complex Alloys". The purpose of this proposal is to develop a predictive theory, which is validated by experiments on well-characterized peritectic and other complex systems. A rich variety of microstructures, that can be formed in complex systems, have not been addressed either theoretically or through critical experiments. Although the fundamental processes of nucleation and growth are well understood, the application of these principles to time dependent microstructure evolution is highly complicated due to competing processes. As many of the commercially important rare earth alloys fall into this class of materials, it is hoped that there will be significant industry participation in the proposed center. During the next few weeks, I will be contacting the materials producers to determine interest. Anyone else interested, please contact me at the Rare-earth Information Center (RIC): telephone (515) 294-2272, fax (515) 294-3709 or email - mccallum@ameslab.gov

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