OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY
FACT SHEET

Radioisotope Power Systems

Materials Production and Technology Program

Alloy and Component Development and Testing

Agencies of the United States government including the Departments of Energy and Defense and NASA have increasing needs for advancements in materials for more demanding applications. The Radioisotope Power Systems Program at ORNL has a 30+ year history of materials development (various metal alloys and carbon bonded carbon fiber) and fabrication of unique components for the Department of Energy, NASA and other government agencies. In addition to production activities, the Program provides a wide range of capabilities that span the entire sphere of alloy design, production, mechanical property testing, component testing and qualification. Manufacturing equipment and expertise exist to cast metal alloy ingots and process them into finished metal shapes by extrusion, rolling, forming, machining, assembly, and welding. Nondestructive testing and quality systems are employed throughout the process to ensure customer requirements are maintained. Areas of expertise can be grouped into the four following areas:

Alloy Design, Production and Processing

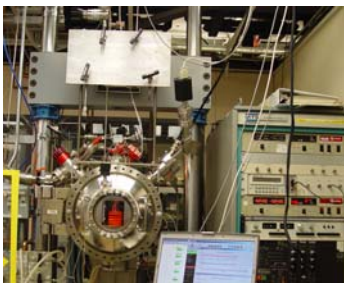
- Vacuum Arc Remelting
- Vacuum Electron Beam Melting
- Extruding
- Heat treating
- Rolling
- Sintering

Component Manufacture

- Metal forming
- Heat treating and sintering
- Machining
- Arc, electron beam, friction stir and laser welding
- Inert-gas glove box welding
- High temperature carbonization
- Surface modification

Testing and Evaluation

- Weldability testing
- Mechanical Properties testing
- Impact testing
- Creep and stress-rupture testing
- Burst testing
- Physical Properties



Quality systems and Nondestructive Testing

- Quality systems to DOE orders and consensus standards
- Radiography
- Ultrasonic
- Thermal Imaging

Alloy Design, Production and Processing

Specialty alloys are produced in development or small production size lots using powder processing, electron beam melting and vacuum arc remelting. Extensive experience exists for the production of reactive, refractory, and precious metal alloys. An example of a high performance alloy developed and produced at ORNL is the iridium DOP-26 alloy. This platinum group alloy is used to encapsulate radioactive materials for NASA deep space missions. The alloy was designed for high-temperature strength and ductility to survive impact damage from potential accident scenarios. Other examples of developmental alloys are refractory alloys for the friction stir welding tool for welding heat resistant alloys. Further processing of ingots is accomplished by extruding, rolling, and heat treating to produce finished sheet and/or foils.

Component Manufacturing

A wide array of room temperature and high temperature manufacturing equipment is employed to produce final shapes or components. A unique carbon bonded carbon fiber (CBCF) insulating material to provide reentry protection to nuclear fuel clads in radioisotope thermoelectric generators is produced in ORNL facilities maintained for vacuum molding, high temperature carbonization and machining of insulating components. ORNL has experience in forming and machining many alloys including steels, superalloys, refractory and precious metals. Other processing technologies employed are air, vacuum, hydrogen, and inert atmosphere heat treating, diffusion bonding and powder sintering. One component made using these processes is a high temperature precious metal filter. ORNL has vast experience in welding and brazing technology including arc processes, laser, electron beam, and friction stir welding. Surface modification of alloys and components is performed by laser and plasma arc lamps.

Testing and Evaluation

Testing and evaluation of materials, components, and small structures can be performed with a wide variety of testing techniques. Capabilities include tensile, compression, torsion, bend, creep, fatigue, stress relaxation, Charpy impact, fracture toughness (including J-integral), and corrosion testing. Pressure burst or biaxial creep-rupture testing of pressurized capsules is used for more complex stress loadings or for validation of designs. Environmental chambers are used to test in a wide range of temperatures, gas atmospheres, or in vacuum including ultrahigh vacuum. Numerous machines are available for different load levels and speeds. Weldability testing and simulation can be performed on specialty alloys including Sigmajig, Varistraint, and Gleeble test methods. These tests can be used for determining the effect of minor elements contents to the weldability of an alloy or simulate the effects of welding on the microstructure.

Quality Systems and Nondestructive Testing

Quality systems encompass activities to ensure that work is performed in a predictable and precise manner and that results are defensible and transferable to other agencies or contractors. Quality systems are conducted to DOE orders and national consensus standards. A listing of employed quality systems are DOE Order 414.1C, 10CFR 830, Subpart A, ANSI/ISO/ABQ Q9001, ANSI Z1.13 and NQA-1.

An entire array of nondestructive testing capabilities is available for the evaluation of alloys and structures including radiography, liquid penetrant, visual, ultrasonic, and thermal imaging.

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