ACTIVITIES ON HIGH DENSITY UMO FUELS FABRICATION

[1]Oliveira, F.B.V.de; [2]Gracher, R.H.; [1]Durazzo, M.

[1]Centro do Combustível Nuclear - IPEN/CNEN-SP; [2]Universidade Federal de Santa Catarina - UFSC

Keywords: high density nuclear fuels; uranium molybdenum fuels; low enriched uranium.

CCN is now regularly producing UMo alloys by arc and induction melting, in order to acquire the knowledge in the high density-LEU fuels technology. Melting activities are now possible due to the support provided for us by means of the BRA 4/053 Brasil / IAEA cooperation project. Using both methods to produce the alloys, we can note some remarkable differences, leading us to some conclusions about its main advantages and disadvantages. Due to differences in the load capacity and also in the operational features between the furnaces, the experiments were carried out in quite different manners. Relating to the arc furnace, due to its base plate configuration, we machined its surface in order to obtain three semi-spherical boats, where the charge is assembled. The maximum load capacity of each boat is of the order of 40g, so we can work with 120g, maximum, per batch / experiment. This is one of the arc melting technique main limitation, which can be relegated if we consider that the process to open the arc and the melting of the alloy itself is a very quick process. This process can be controlled by means of the arc furnace control panel or by means of a pedal, after vacuum and the chamber filling with an inert gas. All these operations are very easy and quick, like the application of the arc above the sample, made by the operator's hands. So, no geometrical considerations must be taken into account in order to optimize the melting procedure. In the induction melting, charge geometry are essential, since we must provide to the furnace that the magnetic field lines generated by the coil are passing equiaxedly through the sample. In our case the induction furnace charge consist of an uranium cylinder surrounded by small pieces of molybdenum. This cylinder is disposed with its central axis parallel to the coil axis, inside of a cylindrical alumina / zirconia crucible. With these conditions obeyed, we must to evacuate and then fill the furnace chamber with some inert gas. Melting control is made by means of a panel, by means of which we can increase the power / temperature until the required. Since the furnace chamber is very large, purge, vacuum and filling process are very slow, demanding at least one day to be accomplished. Melting procedure is also fast, spending only a few minutes in the case of UMo. However, remarkable differences are still observed, mainly in the microscopic characteristics of the materials as cast. Comparing both figures, we can observe that a few number of phases are presented in the UMo arc melted. MEV / EDAX, together with optical microscopy analysis, indicated that at least three different UMo phases are present, the darkest phase referred to an uranium oxide and another to a pure uranium. This wide range of products in the same sample indicates that there is a problem in the charge homogenization. To verify the correctness of this assertion, we proceeded with the remelting of the samples one to four times, and the microscopy analysis indicated that the samples are now well homogenized, no more than two phases presented in each sample. So, to enable the material to go to the thermal treatment step, a number of remelts must be necessary, even working with small charge amounts. (FIG.1) - U10Mo, arc melted. (FIG.2) - U10Mo, induction melted. In the induction-melted samples this problem is not present, since the optical microscopy and DRX examinations indicated the presence of two phases, as expected in an as-cast UMo alloy. These phases are alfa-U, mainly in the grain boundaries but also in small quantities inside the grains, and gamma-U, the material in the grain. So, with only one melting step with a larger amount of charge in comparison with the allowed in arc-melting furnace, we can obtain a material with the desired quality, ready to the steps of thermal treatment and / or powder fabrication.

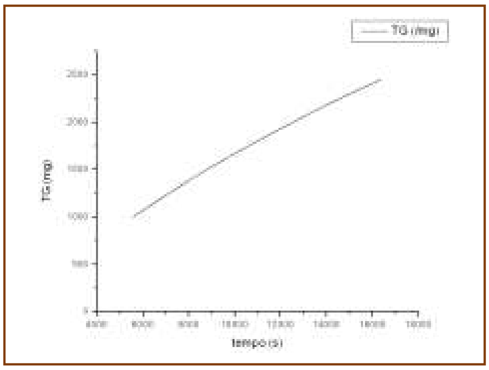

FIGURE 1 - Tipical behaviour of a TG x time curve.

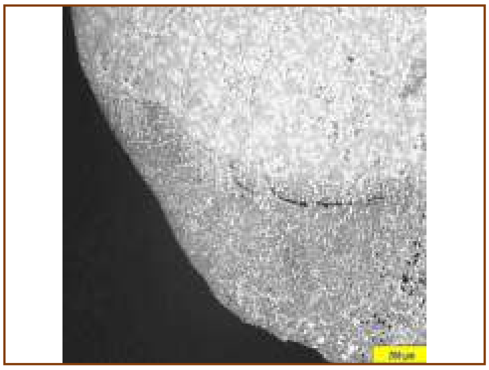

FIGURE 2 - Tipical image of an hydrated particle.