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MICROSTRUCTURAL CHARACTERIZATION OF $U0_2$-Xwt%Gd_20_3 FUEL PELLETS OBTAINED BY AUC CO-PRECIPITATION AND MECHANICAL MIXING PROCESSES

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Abstract – Microstructural characterization of $U0_2$-**X**wt%Gd_20_3 nuclear fuel were carried out by chemical analysis, surface area, X-ray diffraction including lattice parameter (Table 1), SEM, WDS and image analysis (Fig. 1). The sintered pellets obtained by co-precipitation process presented better performance for using as nuclear fuel than to those obtained by the mechanical mixing process.

The demand for extended fuel cycles and higher burnups is a strong incentive for the use of gadolinium in pressurized water reactors (PWR). Gadolinium is incorporated into UO_2, mainly in the form of a solid solution[1-6]. This work presents a microstructural characterization this kind of fuel obtained by two of the most important techniques of incorporation of Gd_2O_3 into UO_2, namely, co-precipitation and mechanical mixing processes.

Sintered fuel pellets of $U0_2$, as reference, and $U0_2$-Xwt%Gd_20_3 were obtained with X= 2, 5 and 10. Sintering was carried out at 1700 ºC under high purity H_2 atmosphere. The sintered pellets were characterized as for chemical analysis, surface area, X-rays diffraction (including lattice parameter), SEM, WDS and image analysis.

It was not possible to detect the presence of gadolinium phase by X-ray diffraction, since the main peaks of this phase are coincident with those of the UO_2 phase. However, the peak shifts to higher angles shows that there is a decrease in the lattice parameters, which leads to the conclusion that gadolinium enters the lattice as a solid solution. The co-precipitation process presented larger grain sizes and smaller lattice parameter, see Table 2. The literature[1-6] mentions that large grains reduce the release of fission gaseous products and thus enhance the fuel performance. This fact suggests better performance of co-precipitation process. In addition, the formation of solid solution in the co-precipitation process presented an advantage over the mechanical mixing process from the view point of homogeneity of gadolinium in solid solution. The results are discussed in this work and compared to each other and to those in literature.

Table 1: Lattice parameter of sintered fuel pellets (Å).

Mixture Proportion	Co-Precipitation Process	Mechanical Mixing Process
$U0_2$-**2**wt%Gd_20_3	5.46606 (5)	5.47019 (4)
$U0_2$-**5**wt%Gd_20_3	5.46167 (6)	5.46568 (9)
$U0_2$-**10**wt%Gd_20_3	5.45041 (6)	5.46034 (9)
$U0_2$	5.47074 (4)	

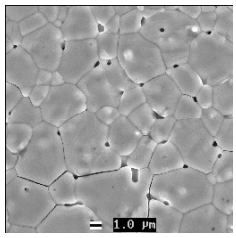

Figure 1: UO_2 fuel pellet obtained by precipitation process.

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