Obtaining rutile support membranes for nuclear waste treatment

J. G. SANTOS[1], E. E. M.OLIVEIRA[1], E. T. RUAS [1], E. F. SILVA[1], M.H. SILVA[2], E.C. LIMA[2]
e-mail: jg@ien.gov.br
[1] SEMAT, IEN, [2]Bolsista PIBIC/CNEN

Keywords: ceramic membrane, ceramic support, rutile.

Polymeric membranes suffer from certain limitations when used in aggressive environments, such as, pH and elevated temperature [1]. Our proposal is the development of ceramic membranes supports of titanium oxide for nuclear waste treatment from waste generated in the research activities at IEN, as they show resistance to radiation and chemicals superior to polymeric membranes. The selection of material powder, particle size, processing method and sintering temperature strongly affects the characteristics of the pore size ceramic support [2-3]. In this study, titanium dioxide in the rutile phase was evaluated as possible material for membranes support with size particle larger than TiO_2 Degussa, favoring the formation of a larger pore size for the support. This means that larger particle size results in an increase of the pore size and permeability, while there is a decrease in linear shrinkage and mechanical strength. To obtain ceramic support, 3 suspensions of commercial RKB-2 rutile titanium dioxide (Tiona) containing starch corn as pore-forming agent in the proportion of 0, 15 and 30% were prepared. Suspensions containing 10% of PVA were dried in the spray dryer and the granulated powder was compacted in the form disks, sintered at 1050, 1100 and 1150 °C/1h. The effect of the sintering temperature and the starch corn concentration was studied to determine the sintering temperature that would promote a porous support with permeability and mechanical strength adequate to ceramic support.

Table I – Apparent density and porosity

Content starch (%)	Temp sintering (ºC)	Apparent density (%)	Apparent porosity (%)
0	1050	52,03	47,97
15	1050	51,80	48,20
30	1050	45,39	54,61
0	1100	57,81	42,19
15	1100	49,93	50,07
30	1100	39,25	60,75
0	1150	58,26	41,74
15	1150	56,95	43,05
30	1150	47,19	52,81

Table I shows the results of values of density and porosity of the sintered titanium dioxide rutile at temperatures 1050, 1100 and 1150 ºC. The analysis of the results so far indicate that a high level of porosity can be achieved with all the temperature sintering employed, independent of pore forming agent concentration. However, the support treated at 1050 ºC shows poor mechanical strength and could not be tested, showing that titanium dioxide in the rutile phase can only sinter above 1050 ºC. Figure 1 shows that the permeability (slope of the lines) varied greatly (13 and 153 $Lm^{-2}h^{-1}MPa$ for 1100 °C; 63 and 135 $Lm^{-2}h^{-1}MPa$ for 1150 °C). This permeability can be used for evaluating the supports obtained in this work

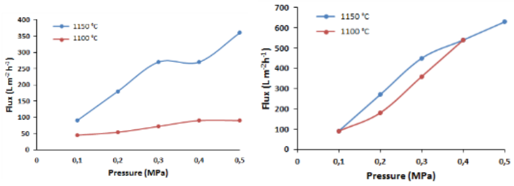

Figure 1 – Permeability of the supports with 0% e 30% of the starch corn sintered at 1100 and 1150 °C

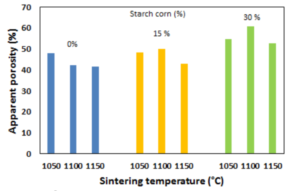

Figure 2 – Apparent porosity versus sintering temperature

Figure 2 shows the variation of the apparent porosity as a function of content starch and sintering temperature. The graph shows that porosity increases with increasing starch content and tends to decrease with increasing sintering temperature. The pore-forming agent was effective to promote porosity and good permeability, being completely valid to test a commercial TiO_2 rutile as support ceramic.

References

[1] OLIVEIRA, E. E. M. **Avaliação de membranas de nanofiltração para o tratamento de rejeito radioativo líquido**. 2013. Tese (Doutorado em Química)- Instituto de Química, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2013.
[2] SANTOS, J. G.; CORREA, R. A.; OGASAWARA, T. Synthesis of nanocrystalline rutile phase titania at low temperatures. **Materials Science-Poland** , v. 27, p. 1067-1076, 2009.
[3] SANTOS, J. G.; LAMY, C. A. O rutilo como alternativa para fixação molecular de rejeito nuclear de alta atividade. In: INTERNATIONAL NUCLEAR ATLANTIC CONFERENCE, 2005, Santos. **Proceedings**... Santos: ABEN, 2005.