Intergranular corrosion by sodium of yttria doped thoria used as solid electrolyte of oxygen sensors in Sodium Fast Reactors

Laurent BRISSONNEAU[1], Yanis CHERKASKI[1], Nicolas CLAVIER[2], Nicolas DACHEUX[3]

[1] CEA Cadarache, France
[2] DNRS / ICSM, France
[3] Université de Montpellier / ICSM, France

As steel corrosion in sodium depends on the content of oxygen in sodium, potentiometric oxygen sensors are developed to monitor this impurity in future sodium fast reactors. Yttria doped thoria (YDT) is one of the only oxides which might be used as solid electrolyte that can withstand corrosion by sodium. However, the conditions for the long term compatibility of YDT in sodium are not well understood. A series of sodium corrosion tests was then conducted on YDT pellets of controlled microstructure, obtained by oxalic precipitation and specific sintering conditions.

No corrosion attack can be observed on YDT pellet surface, but intergranular corrosion is evidenced by SEM observation of fracture surface. The fracture surface evolves from purely transgranular before the sodium test to intergranular in the regions where sodium penetrates. Sodium can also be detected in this zone by EDS. The kinetics of sodium penetration changes with time or microstructure. In Impedance spectroscopy measurements performed after corrosion test, the blockage (grain boundary) contribution disappears.

Pellets with Zr or Si inserted as model impurities behaves differently. Zirconium has no effect at the lower contents, when silicon has a deleterious effect.

These experiments show that the microstructure has a major effect on the kinetics of sodium penetration in YDT. Further experiment will be conducted to quantitatively assessed the influence of temperature and oxygen content.