# Thermal stability of nuclear materials under varying conditions

## INTRODUCTION

Nuclear fuels are exposed to high temperatures and diverse atmospheres throughout their life cycle. These conditions can boost reactivity and accelerate aging. Thermogravimetric analysis (TGA) is used to determine the thermal stability of these materials. It detects mass variations linked to decomposition reactions, under realistic temperature and atmospheric conditions. Combined with Differential Thermal Analysis (DTA), it provides information on the heat released during these decompositions, and it can detect the phase transformations undergone by materials.
The present example reports experiments carried out to test the pyrophoricity (fast reaction with air) of uranium hydride powders.

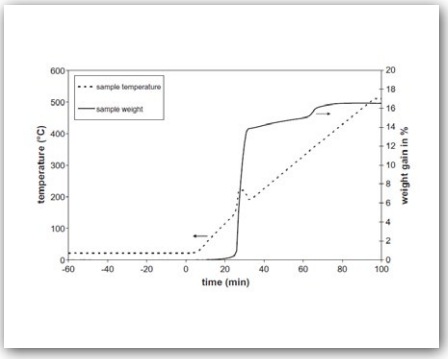


***Figure 1 – TGA signal of the uranium hydride sample.***

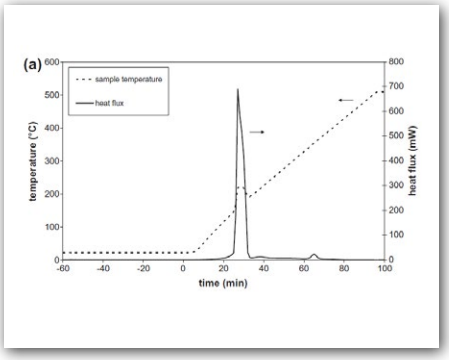


***Figure 2 - DTA signal of the uranium hydride sample.***

## EXPERIMENT

- Sample: uranium hydride ($UH_3$) powder, 40 mg.
- Instrument: THEMYS TG-DTA.
- Temperature: heating from 30°C up to 500°C at 5°C/min.
- Atmosphere: air flow at 100ml/min.

*Reference : C. Ablitzer et al., Journal of Nuclear Materials 432 (2013) 135–145.*

## RESULTS AND CONCLUSION

The TGA signal depicted in Figure 1 illustrates the sample's changes in mass and temperature over time. Upon initiating the heating process, a gradual increase in mass is observed. This indicates that the $UH_3$ sample exhibits a moderate reaction until it reaches temperatures ranging from approximately 140 to 160°C. At this point, ignition takes place, accompanied by a rapid increase in mass uptake. The DTA signal shown in Figure 2 confirms this observation by the presence of a distinct exothermic peak and a corresponding temperature rise.

After a few minutes, the samples' reactivity decreases. A small event is noticeable on the DTA curve, at about 200°C. A more intense final peak of reactivity occurs at about 300 C as seen on both TGA and DTA signals. This data set, together with extra measurements could help the authors concluding that the pyrophoric behavior of these powders could be mitigated with a pre-oxidation of the particles' surface.

## INSTRUMENT

**THEMYS STA**

ACCURATE AND SENSITIVE ULTRA-HIGH TEMPERATURE
heat flow measurement with Tri- Couple DTA technology

ULTRA-HIGH TEMPERATURE CAPABILITY
***to 2400°C*** with a single furnace.

MODULAR ADAPTIONS ALLOWING
TGA only, DTA only, TG-DTA, and TMA up to 2400°C, DSC only and TG-DSC up to 1600°C all in one instrument

EXTERNAL COUPLING CAPABILITY
designed for evolved gas analyzers (FTIR, MS, GCMS, MSFTIR, or FTIR-GCMS)