THERMAL GRAVIMETRIC ANALYSIS WITH GAS CHROMATOGRAPHY AND MASS SPECTROMETRY (TGA-GC-MS) OF MATERIALS USED IN SPACE INDUSTRY

Thermal gravimetric analysis with gas chromatography and mass spectrometry (TGA-GC-MS) is an analytical technique for determination and identification of offgassed compounds and products of decomposition during temperature increase applied to a material. This poster presents a description of all steps of a material complex analysis using the combination of instruments and application example of data acquired with this tool.

The technique heats a material in a TGA at specified temperature gradient. Purge gas (He, N2 or Ar) delivers up to 15 samples of offgassed compounds collected at defined temperatures to the heated sample loops through the heated transfer line. Collected samples are injected in sequence into GC. GC separates a mixture of compounds present in a sample and delivers them sequentially to MS detector. MS breaks the molecules into charged fragments and records intensity of detected ions in a spectral plot called mass spectrum. Each compound has a unique mass spectrum collected in a library. The compounds are identified by matching a mass spectrum of unknown compound with the one from MS library.

TGA-GC-MS is a combination of various instrumental analytical techniques which allows to determine the products formed at specified temperatures during thermal mass loss of a material.

1. Thermogravimetric Analysis (TGA) measures the weight change of a material as a function of temperature in a controlled atmosphere. The graph helps to choose sampling points at desired temperatures based on material weight loss and speed of offgassing and material degradation.

2. Sampling storage unit automatically collects samples during TGA analysis and couples TGA with gas chromatograph.

3. Gas chromatography (GC) separates the different components of a mixture and delivers them sequentially to a detector (mass spectrometer).

4. Mass spectrometer (MS) cleaves molecules on fragments (ions) and measures their intensity. The graph of the ratio of the ions is called mass spectrum. Mass spectrum is used for molecules identification.

5. Distribution of offgassed compounds and products of material decomposition at the temperatures applied through the thermogravimetric analysis.

CONCLUSIONS

TG-GC-MS is a powerful tool for space industry materials testing and development. In addition to mass loss during TGA analysis it shows the change in complex gas blends evolved from desorption and decomposition during temperature increase applied to a material. Since materials in space should be working at wide range of temperatures, the information of exact offgassing and decomposition substances expected at different temperatures gives a good addition to a simple TGA analysis.