Analytical Answers

The Information You Need… When You Need It

Thermogravimetric Analysis (TGA)

Thermogravimetric Analysis (TGA) is an analytical technique which measures the mass of a sample as a function of time and/or temperature. Plots showing mass loss (or in some cases, mass gain) as a function of time or temperature yield information on the composition and changes in the sample.

How it Works:

Samples analyzed by TGA are typically solids, although liquids can be characterized as well. The sample is loaded into a high-temperature crucible, which is suspended in a computer-controlled furnace. The crucible hangs down off of one arm of an electrobalance with microgram sensitivity. Temperature programming, with optional automatic switching of furnace purge and reaction gases, subjects the sample to a temperature profile, typically ramping from room temperature up to a set maximum, increasing at a steady rate. Optional isothermal steps allow time for the sample to equilibrate when reaction/purge gases are switched, or to study changes over time at a fixed elevated temperature. Sample mass and furnace temperature are continuously recorded over the
course of the run.

Applications Include:

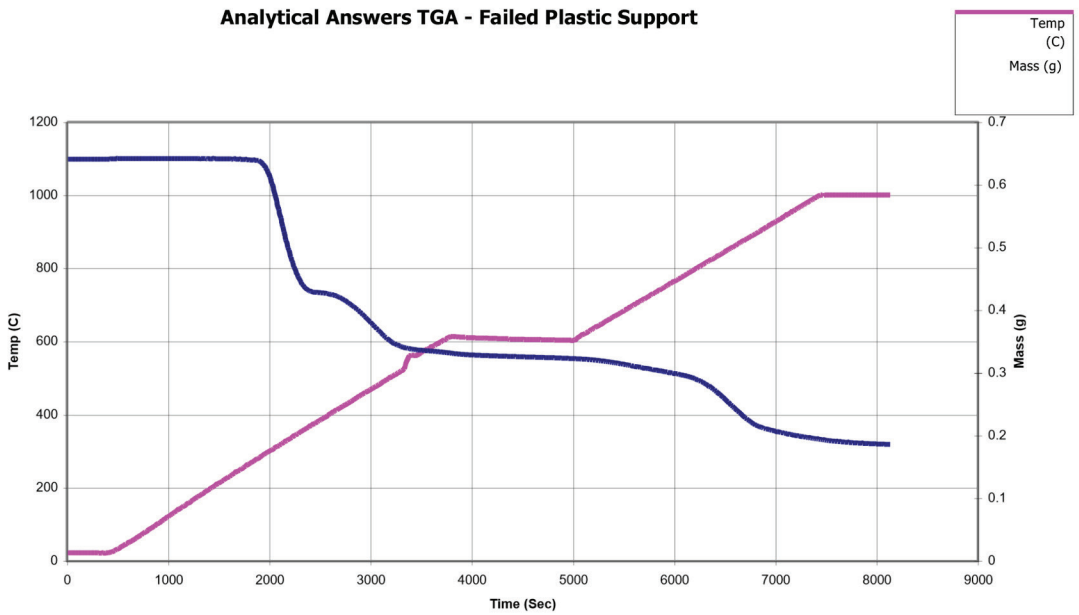
- Organic fillers
  - Polymer blends
  - Oils in rubber
  - Plasticizers in polymers
- Inorganic fillers
  - Carbon black
  - Calcium carbonate
  - Fumed silica
  - Glass fiber
  - Alumina, titanium dioxide, et. al.
- Outgassing of materials
- Flame retardants in polymers and fabrics
- Gas absorption in zeolites and catalysts
- Inert and reactive gas studies

- Quality Control
  - Quantitative Loading of plasticizers and inorganic fillers in polymers.
  - Cure quality of carbon fiber composites.
  - Residual solvents in pharmaceuticals.
  - Moisture levels in pharmaceuticals, polymers, and inorganic powders.

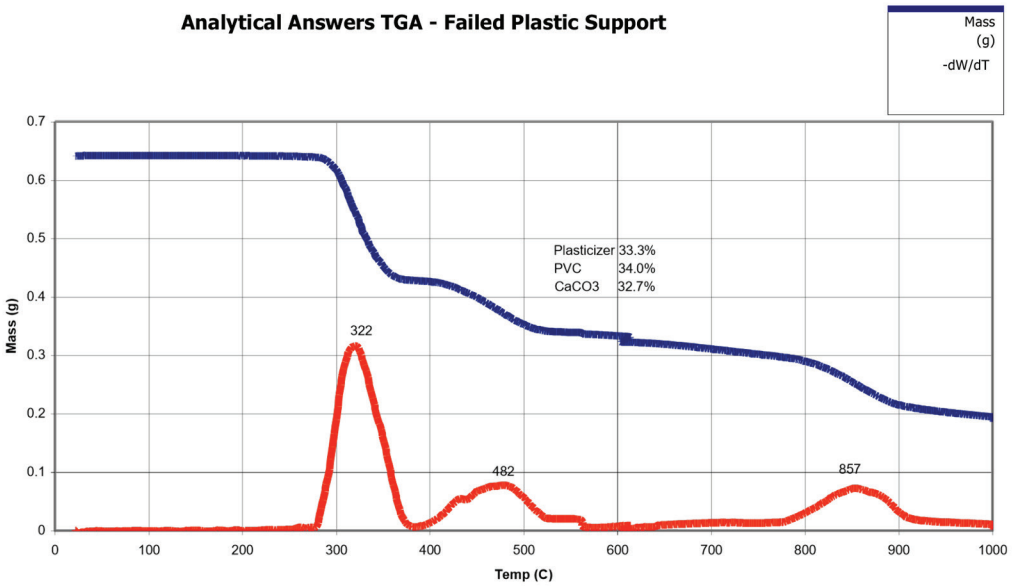
Data Presentation:

Sample mass and temperature data is processed to produce plots of temperature as a function of time, mass as a function of time, mass as a function of temperature, and the rate-of-change of mass as a function of temperature. Through interpretation of these plots, we can determine degradation points, amount of plasticizer oils, proportions of different polymers in blends, oxidation onset

We present the sample's changes in a graph which shows the relationship between temperature and sample mass over the course of the analysis.



Temperature and mass as a function of time show instabilities in the material at elevated, constant temperatures, as well as a simple verification of correct operation of the balance and furnace over the course of the run.



The plot of mass as a function of temperature shows the amount of mass loss due to thermal events such as 'boil-off' of moisture, solvents, and plasticizers, degradation of polymer components, and breakdown of inorganic species, such as the transition of calcium carbonate to calcium oxide at ~ 850 C shown above. The associated plot of mass change as a function of temperature (dW/dT) shows the temperature points where the maximum mass change is occurring. This information is useful for understanding the thermal events occurring at the given temperatures, and uncovering multiple, overlapping thermal events.