

# See what is really happening within your furnaces.

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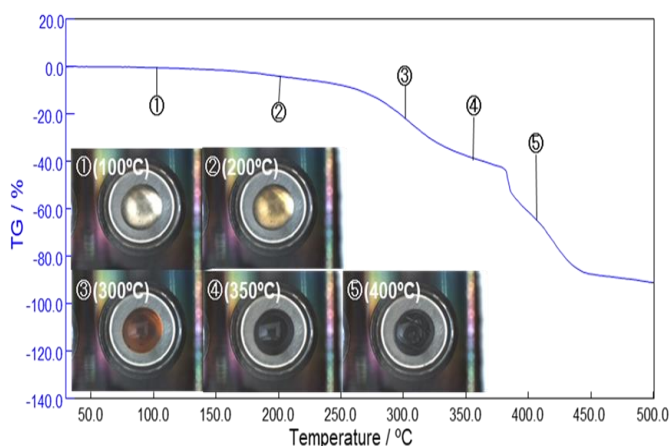
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## Abstract

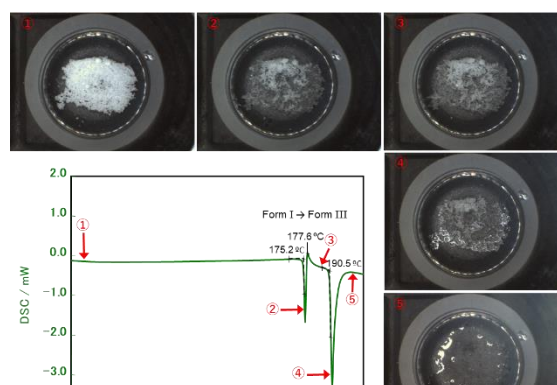
Although thermal analysis techniques like DSC, STA, DMA and TMA have been around for a long time, it's always been a challenge to know what is really happening to our samples during an experiment. Being able to see what happening within the furnace of a thermal analysis instrument can provide valuable information such as sample positioning, size/shape and colour change.

Understanding thermal analysis results can be challenging especially when you don't have much experience with the technique. It can also be laborious to explain how different thermal analysis techniques to people without experience. Being able to see the sample during a measurement helps to either understand results or explain them clearly. Figure 1 clearly shows the reason of why an increase of sample mass in a TGA measurement was measured between 350C and 400C. Images 4 and 5 show that it is due to gases trapped within the sample which are bursting out and caused the sample to move.



**Figure 1:** A TGA curve shows an artefact between 350C and 400C which is explained by visible image 4 and 5.

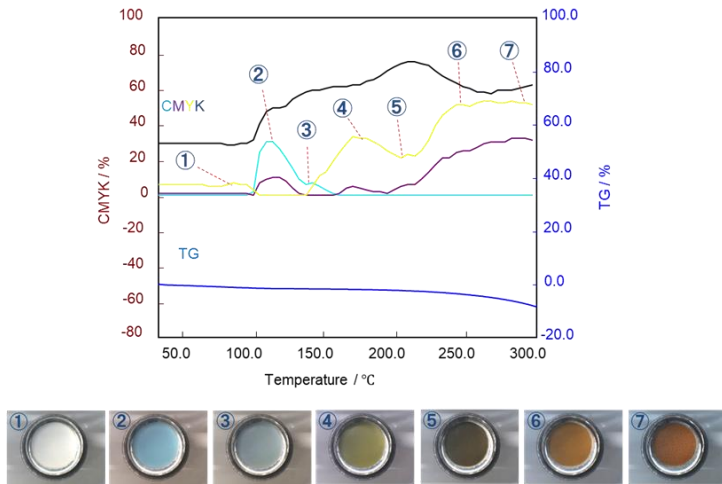
Being able to see your sample change during a thermal analysis experiment can also provide insight on its dimension change as well as its crystalline form. Figure 2 shows DSC results of Carbamazepine Form I. We can clearly see the melt of from one as well as the recrystallisation to form 3 which is follow by its melt. The visible images confirm the change in crystalline form. Visible images can also allow you to measure changes in shapes and dimensions during thermal analysis.



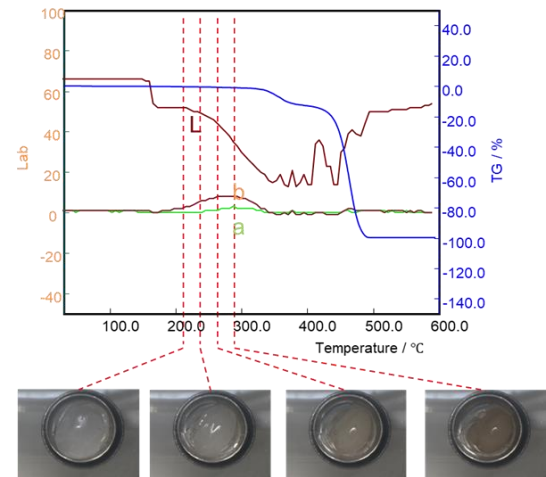
**Figure 2:** A DSC result of Carbamazepine form 1 showing its melt, recrystallization to form 3 and its melt. Each thermal changes are captured by the visible image.

Another important parameter which can be measured with visual images is sample colour change during analysis. Some materials will go true wanted or unwanted colour change over specific temperature range. Measuring the effect of time or temperature while collecting visible images in a thermal analysis instruments allows accurate temperature control, study of thermal behavior as well as colour changes which couldn't be measured otherwise. Colour analysis is done through using pixel colour information which allows the use of colour models such as RGB, Lab, CYMK. Figure 3 shows the effect of temperature on a thermal paper using CYMK. Even if the weight loss is minimal, we can observe the changes of colours through the visible images as well as

with the CYMK values. Another example is the undesirable effect of heat on materials over time or due to temperature change. Figure 4 shows an example of a polypropylene material which change from white to yellow from 200C to 300C even if no weight loss is observed. The increase in b value from the Lab colour model shows that the material is getting yellow above 200C. The use of colour models is essential to remove the arbitrary measurement if the colour measurement was done by an analyst. Since each of us sees colour slightly different, analyst one could give a different answer to analyst two. By using colour model, we improve consistency.



**Figure 3:** Thermal paper going through colour changes during a TGA measurement. Colours are captured by the visible image and changed are also showed using CMYK colour model.



**Figure 4:** The effect of temperature on a polypropylene sample. Lab colour shows that samples becoming yellow above 200C as the b value increases.

There are many more applications where visible images in combination with thermal analysis which are still to be discovered. This presentation will go through the advantages of being able to see the samples while using thermal analysis techniques (DSC, STA, DMA and TMA). Real examples will be used to show the power of the techniques and it will also cover the extra information which can be extracted from a visible image (e.g. RGB values).