Forensic identification of mechanical pencil leads by TG/DTA with optical observation

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Introduction

Ignition studies of wood and rubber materials have been performed in the past using a TG/DTA system that allows visual sample observation. The ignition is caused by oxidation decomposition of the carbon, but measuring a variety of carbon samples has shown that some samples did not experience ignition .

In this report, analysis of mechanical pencil lead is presented. Initially chosen for study due to its high carbon content, visual observation during TG/DTA analysis yielded interesting results. While lead did not show an ignition flash, the images allowed characterization of the oxidative decomposition based on various types of carbon and other ingredients. Furthermore, while elemental techniques such as XRF can be used in identifying pencil lead on paper, the limited sample quantity can be problematic. The optical images collected during TG/DTA analysis revealed characteristic behaviors of the pencil marks. As a result, the technique can be useful in identifying types of lead.

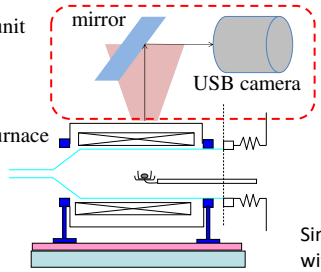
Samples and Conditions

Sample

3 kinds of lead for a mechanical pencil

heating rate : 10 ºC/min
purge gas : Air 200 mL/min

Instrument

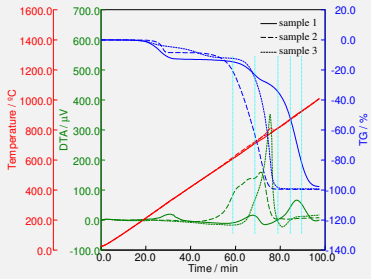


furnace

Simultaneous Thermogravimetric Analyzer STA7200RV with sample observation unit RV-3TG
(Hitachi High-Tech Science Corp.)

Results

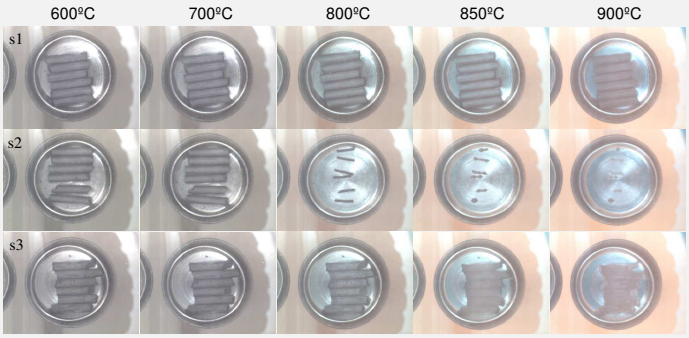
Leads



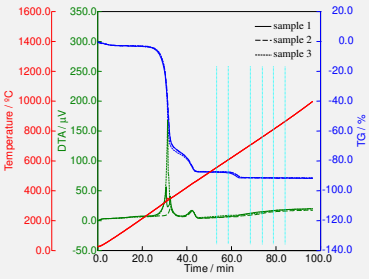
sample weight : 7 mg
sample pan : Pt open pan

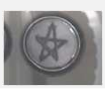
The optical image of 900 degree shows that sample 1 is the almost same as shape before the measurement. It means that the porous was made by decomposition of carbon.

Sample 3 also looks a remained ash same as sample 1.



Letter





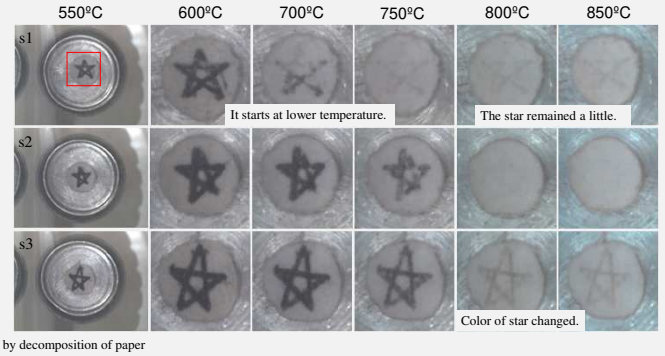
A star mark was written using a mechanical pencil. (refilled each lead)

sample weight : 1 mg (paper)
sample pan : Pt open pan

The optical images show that black color disappeared by decomposition of carbon. It is different from the measurement of leads.

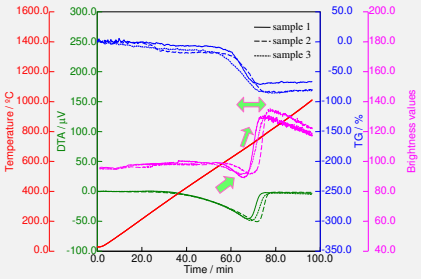
Initial temperature of disappearance is lower in sample 1.

Sample 3 starts to disappear at temperature range same as sample 2. At last, color of sample 3 changed, because sample 3 had a residue in measurement of lead only.



Shrank by decomposition of paper

Leads



Brightness values mean color brightness of images. It was calculated by the image processing software.

The curves of brightness values show that initial temperature of brightness change, slope of brightness change and range of changing are different in each samples.

Hexagon was written in the pan directly for excepting the influence of the decomposition of paper.

sample weight : 20 µg
sample pan : Alumina open pan

Summary and Conclusion

- TG/DTA results show that components of leads and decomposition temperature are different. Furthermore, optical images show that the shape changes are different, too.
- In measurements of letter on paper, optical images show that the disappearance of black color at the decomposition of carbon is different. Furthermore, it shows that there is difference of a trace by the residue which depended on lead.
- When brightness values which was calculated by analyzing images overlapped on TG/DTA result, the decomposition behavior is understood as brightness values changed.
- By TG/DTA with optical observation, We could identify the kind of the mechanical pencil leads which was used to write a letter in spite of being a slight small quantity.