Application Note TA6015

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TA6015 - Thermal decomposition of asbestos analyzed by Thermo Mass Photo

Introduction

Asbestos is a set of six naturally occurring silicate minerals, as shown in Table 1, which have specific features: long, soft, and thin fibrous crystals. All types of asbestos give rise to serious health hazards. The total production of asbestos consists of 90% of chrystotile, a few % of amosite, and minute crocidolite. We need the fusion treatment for the disposal of as-bestos waste. Therefore, it is important to collect information about thermal behaviors of asbestos. In this study, we have analyzed the thermal decomposition of asbestos by Thermo Mass Photo.

Instrument: Thermo Mass Photo

Thermo Mass Photo is a versatile measurement sys-tem of thermogravimetry-differential thermal analysis (TG-DTA) and photoionization mass spectrometry (PIMS). In this system, weight change, endothermic or exothermic phenomena, and evolved gases can be analyzed simultaneously. Therefore, Thermo Mass Photo has considerable promise as an analytical tool for fundamental research, qualification control, and development of new materials.

Table 1: Six mineral types defined as asbestos.

Classes	Types	Chemical Formula
Serpentine group	Chrysotile	$Mg_3[Si_2O_5](OH)_4$
Amphibole group	Amosite	$(Mg < Fe)_2[Si_8O_{22}](OH)_2$
	Crocidolite	$Na_2(Fe^{2+}>>Mg)_3Fe^{3+}{}_2[Si_8O_{22}](OH)_2$
	Anthophylite	$Na_7[Si_8O_{22}](OH)_2$
	Tremolite	$Ca_2Mg_5[Si_8O_{22}](OH)_2$
	Actinolite	$Ca_2[Mg,Fe]_5[Si_8O_{22}](OH)_2$

Thermo Mass Photo has a unique interface, called skimmer type interface, which transfers evolved gases efficiently. We can select Photoionizaition (PI) as well as Electron ionization (EI) on the Mass spectrometer (MS). The combination of PI and EI enables us to classify the gases easily.

Experimental

The standard asbestos, chrysotile (JAWE111), amosite (JAWE211), crocidolite (JAWE311) were placed into Pt pans with 10-20 mg, and heated at 20ºC/min under He atmosphere. The reactions were monitored by TG, DTA, and MS in Thermo Mass Photo.

Results and Discussion

Chrysotile

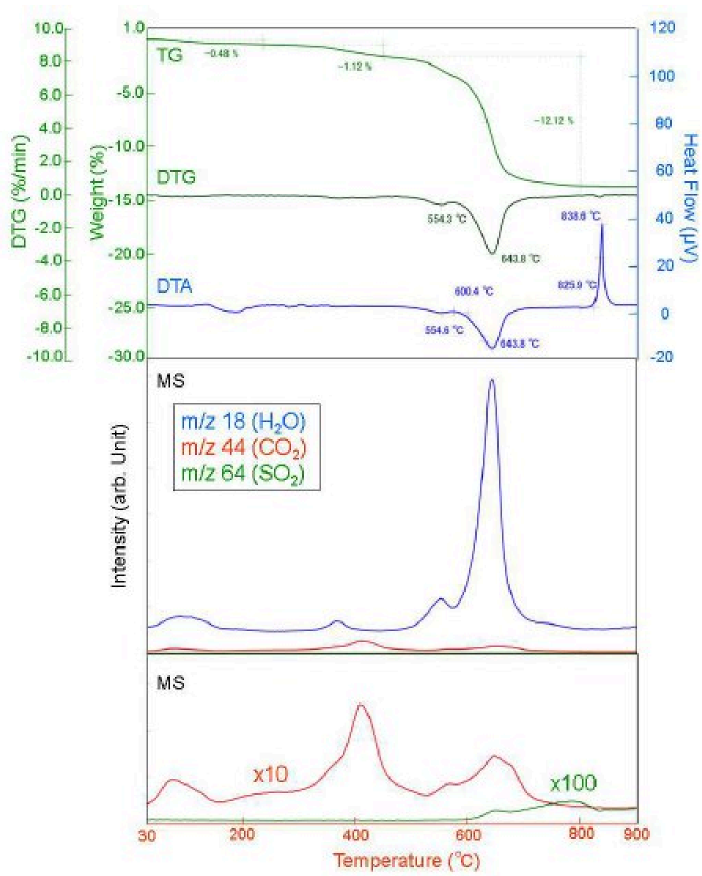

Figure 1: TG-DTA and MS ion thermogram of chrysotile.

Figure 1 shows the TG-DTA profile and MS ion ther-mogram of chrysotile. The weight loss and evolution of H2O from 600 to 700ºC are caused by the dehydration of chrysotile, as shown in the following reaction.

$2Mg_3Si_2O_5(OH)_4 \rightarrow 3Mg_2SiO_4 + SiO_2 + 4H_2O$

The evolution of H_2O from 300 to 400ºC is due to the dehydration of brucite.

$Mg(OH)_2 \rightarrow MgO + H_2O$

In addition, we found the evolution of CO_2 and SO_2. The evolution of CO_2 around 400ºC may be attributed to the decarboxylation of magnesite.

$MgCO_3 \rightarrow MgO + CO_2$

The DTA profile indicates the remarkable exothermic peak at 830ºC, caused by the recrystallization of for-sterite or the formation of enstatite.

Amosite and Crocidolite

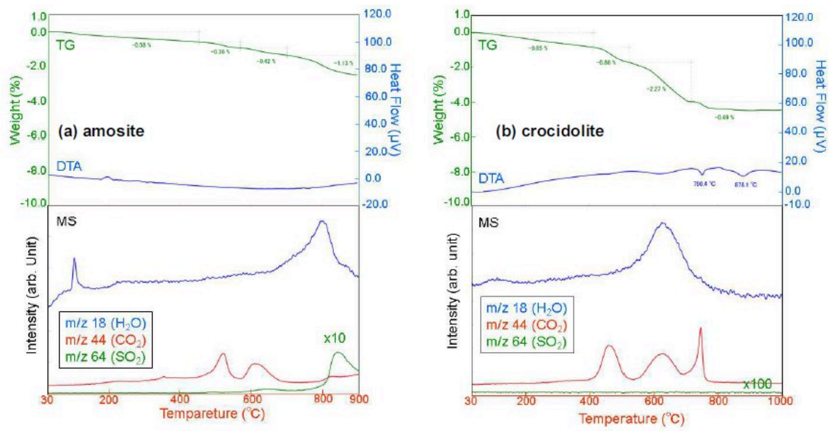

Figure 2: TG-DTA and MS ion thermogram of (a) amosite and (b) crocidolite.

Figure 2 shows the TG-DTA profiles and MS ion ther-mograms of amosite and crocidolite. The dehydration is found around 800ºC in amosite and around 600ºC in crocidolite.

Furthermore, we observed the evolution of CO_2 from some carbonates contained in the standard samples of amosite and crocidolite.

Related products

ThermoMass Photo

An integrated thermal analysis instrument capable of high-precision mass analysis of evolved gases without breaking the molecules, allowing direct measurement.