Study of a thermite reaction: Fe_2O_3 + 2 Al → Al_2O_3 + 2 Fe

Introduction: A thermite reaction (a type of aluminothermic reaction) is one in which aluminium metal is oxidized by an oxide of another metal, most commonly iron oxide. Although the reactants are stable at room temperature, when they are exposed to sufficient heat to ignite, they burn with an extremely intense exothermic reaction. Thermite contains its own supply of oxygen, and does not require any external source (such as air). Consequently, it ***cannot*** be smothered and may ignite in any environment (it will burn perfectly well underwater, for example), given sufficient initial heat. Thermite reaction can be used for quickly cutting or welding metal such as rail tracks, without requiring complex or heavy equipment. This type of reaction can also be adapted to purify the ores of some metals.

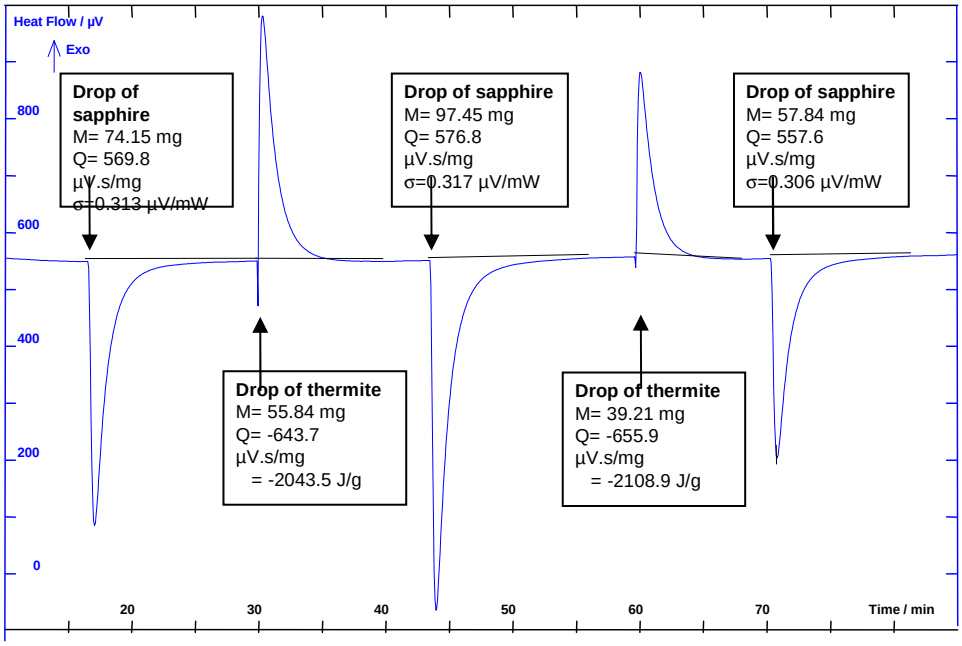

Fig. 1: Calibration and Reaction peaks

Experimental:

Such a reaction can be successfully studied by drop calorimetry and its heat measured.

The experimental set-up consists of:

• the Multi HTC calorimeter with a calorimetric transducer the thermocouples of which are of the B type (max. temperature = 1550℃).

• an alumina crucible with an inner sleeve made of BN (boron nitride). A layer of balls of alumina (≈ 1 mm) is placed at the bottom of the sleeve.

Atmosphere is argon.

Pellets of thermite (Fe_2O_3 + 2 Al) were prepared. They are cylinders with height ≈ 2mm and Ø ≈ 2mm. The corresponding mass is ≈ 50mg.These pellets are dark red coloured.

The temperature is held at 1550℃.In these conditio ns the temperature of the pellets passes instantly from 25℃ up to 1550℃ in the heart of the calorimeter.

The experiment consists in dropping alternatively pellets of sapphire (for calibration) producing endotherms and pellets of thermite producing exotherms.

Conclusion:

The different peaks are integrated and normalized. The results are given in "µV x s / mg".

From the literature value of $\Delta H_{25}^{1550}(Al_2O_3)$ = 1821 kJ/g, it is possible to calculate the sensitivity of the calorimeter (σ in µV / mW).

Using these values of sensitivity, it is possible to calculate the heat during dropping of the two pellets of thermite.

According to **Fig.1**, the average value between the two pellets is – 2076.2 J/g or − 444.3 kJ/mol of (Fe_2O_3 + 2 Al).

Knowing the heat of formation of Al_2O_3 and Fe_2O_3, and $\Delta H_{25}^{1550}(Al_2O_3)$ and ΔH_{25}^{1550}(Fe), we calculated that the enthalpy of the thermite reaction is -547.5 kJ/mol.

Instrument:

High-Temperature Calorimeter
Multi HTC 96
(with "drop calorimetry" detector)

For more details about this work, ask for analysis report # H4023

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