Application Brief

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# DSC Measurements of Shape Memory Alloys

## 1. Introduction

Shape memory alloys' peculiar characteristic of shape changes at certain temperature ranges have brought about rapid commercialization of these materials; i.e. high reliability hydraulic pipe joints. More recently, shape memory alloy research has begun for household applications such as electrical appliances and even underwear.

Of the various shape memory alloys, this brief wi11 describe the durable and high reliability Ni-Ti alloy that is most widely used.

When an ordinary metal is extended, a stress-strain curve similar to that shown in Figure 1 is obtained. When a large load exceeding the metal's elastic limit is applied, inelastic deformation occurs. This deformation cannot be removed even when the load is removed. This means that the metal takes a permanent set. With shape memory alloys, necessary shapes can be memorized into them and the kind of high temperature, ultra-elastic, base phase performance illustrated in Figure 2(a) can be observed. Even when they are deformed into a martensite condition at low temperatures, when they are reheated, they return to the base phase and the originally memorized shape.

This is termed the "shape memory effect (SME)". All shape memory alloys are characterized by ultra elastic performance and the shape memory effect.

Shape memory development of Ni-Ti alloy is based on the thermoelastic martensite transformation, (where transformation hysteresis is low), and the reverse transformation. Both of these transformations can easily be measured by DSC.

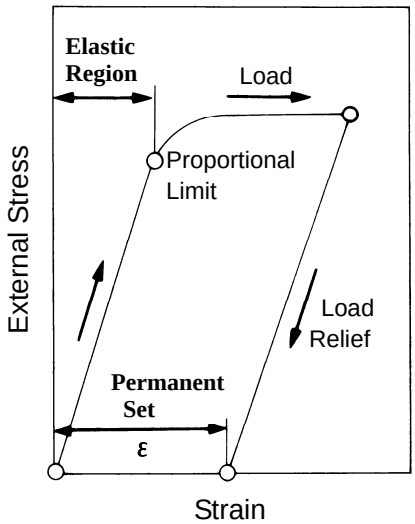


Figure 1 Stress-Strain Curve Ordinary Metal

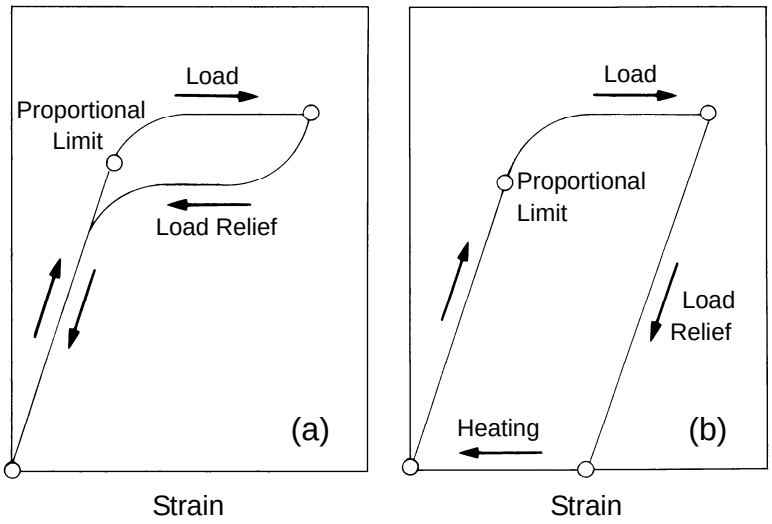


Figure 2 Stress-Strain Curve of Pseudo elastic Metal(a) and Shape memory Alloy(b)

## 2. Experiment and Results

Figure 3 shows a DSC curve for a Ni-Ti shape memory alloy that has been heat treated at 400°C for 10 minutes. Figure 4 shows a DSC curve for the same alloy that has been heat treated for 17 hours at 400°C.

During cooling scans exothermic peaks appear and during heating scans endothermic peaks appear. After extensive heat treating, the single exothermic peak which appears during the Figure 3 cooling scan becomes twin exothermic peaks as seen in Figure 4.

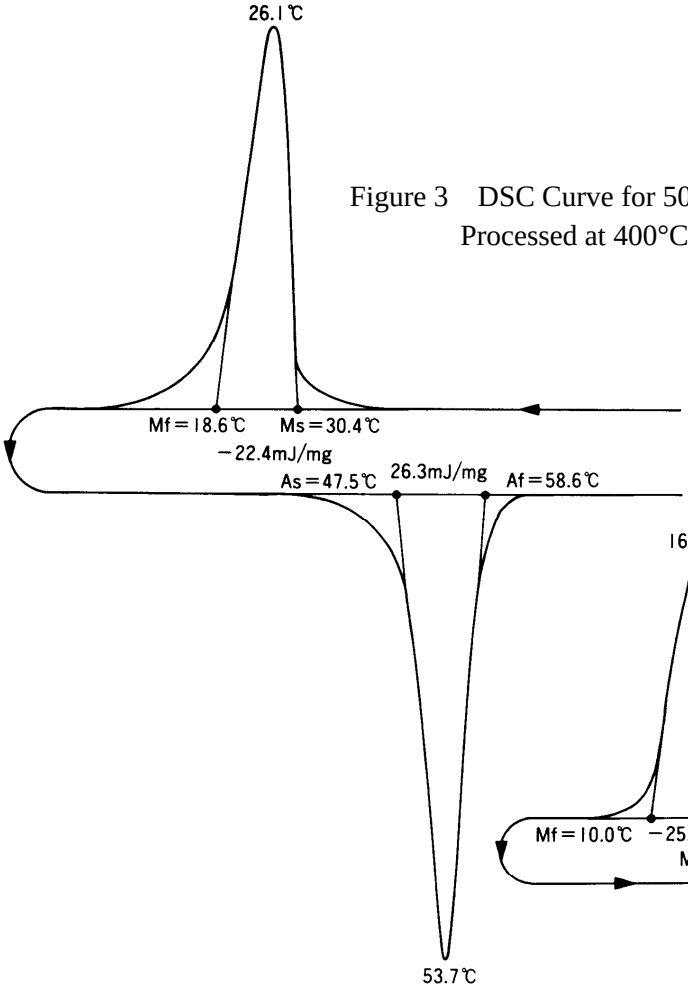


Figure 3 DSC Curve for 50at% Ni-Ti Alloy Processed at 400°C for 10minutes

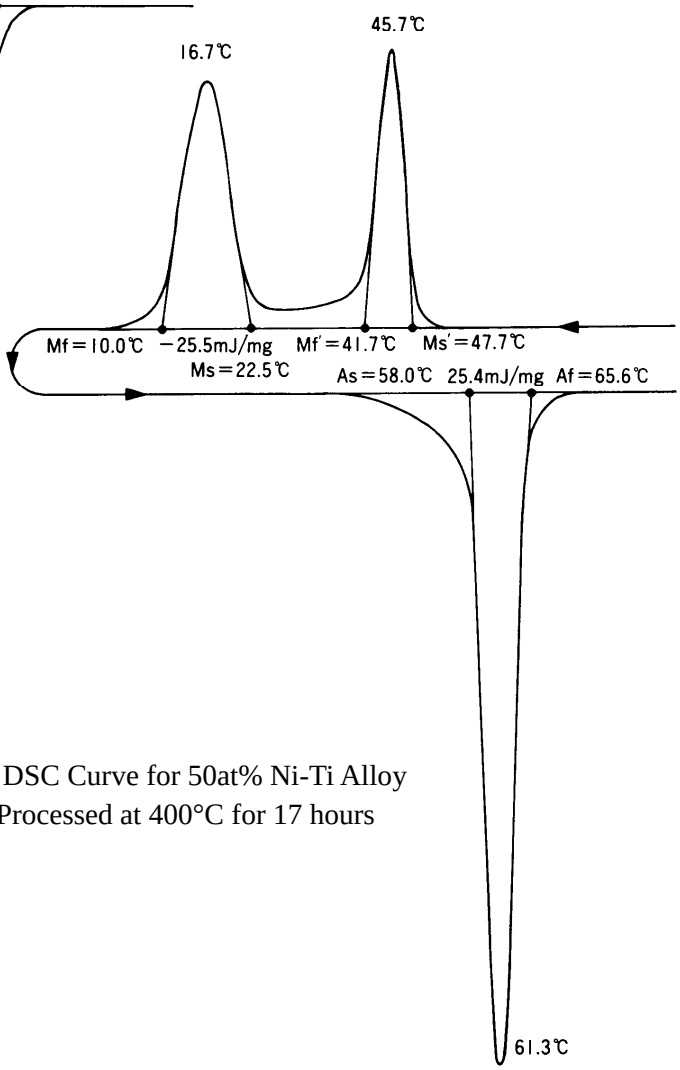


Figure 4 DSC Curve for 50at% Ni-Ti Alloy Processed at 400°C for 17 hours