The Logarithmic Decrement of HgTl Amalgam AT 39.9% At. Tl is Located in the Phase Diagram on the Right Side of 40% At. Tl

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THE LOGARITHMIC DECREMENT OF HgTl AMALGAM AT 39.9% At. Tl IS LOCATED IN THE PHASE DIAGRAM ON THE RIGHT SIDE OF 40% At. Tl

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By means of a toroidal oscillating viscometer logarithmic decrements of dampings have been measured in the presence or absence of HgTl amalgam at 39.9 atomic percent of thallium at different temperatures, ranging from -1 °C to $+15.625$ °C, with fluctuations every 0.25 °C. Measurements were performed in two different periods (1: 05/04/1991–31/07/1991 and 2: 01/08/1991–24/12/1991). In both periods, the eutectic was found at 1.125 °C. When comparing 39.9% at. Tl and 40% at. Tl amalgams, values of the eutectic are perfectly coincident. The logarithmic decrement of the 39.9% at. Tl is located, in the phase diagram, on the right side with respect to the 40% at. Tl.

KEY WORDS: Phase diagram, viscometer damping.

INTRODUCTION

In a previous paper[1] a HgTl amalgam at 40% at. Tl raised some interest about its melting process. In the present paper we focused on the logarithmic decrements of a viscometer dampings, in the presence or absence of the 39.9% at. Tl amalgam at different temperatures from -1 °C to $+15.625$ °C. Measurements were performed in two different periods: the first from 05/04/1991 to 31/07/1991, the latter from 01/08/1991 to 24/12/1991.

EXPERIMENTAL APPARATUS

The toroidal oscillating viscometer used in the present investigation was the same as employed in References 1 and 2.

EXPERIMENTAL RESULTS

The viscometer dampings in presence or absence (δ and δ_0, respectively) of HgTl amalgam at 39.9% at. Tl have been measured at different temperatures, ranging from

$-1\,^\circ$C to $+15.625\,^\circ$C, with fluctuations every $0.25\,^\circ$C and in two different periods (1: 05/04/1991–31/07/1991 and 2: 01/08/1991–24/12/1991).

Experimental results are plotted in Figures 1 and 2. Figure 3 shows mean values of logarithmic decrements recorded for HgTl 39.9% at. Tl from 05/04/1991 to 24/12/1991. Figure 4 shows mean values of logarithmic decrements recorded for HgTl 40% at. Tl from 31/07/1990 to 09/05/1991 (1) Figure 5 shows the comparison between Figures 3 and 4.

DISCUSSION OF EXPERIMENTAL RESULTS

The melting process of the HgTl amalgam at 39.9% at. Tl occurs gradually, as shown by temperature-dependent variations in Figures 1 and 2. At the temperature of $1.125\,^\circ$C we obtained $\delta_1 = 2.9291150 \cdot 10^{-4}$, $\delta_{01} = 2.450750 \cdot 10^{-4}$ (Fig. 1) and
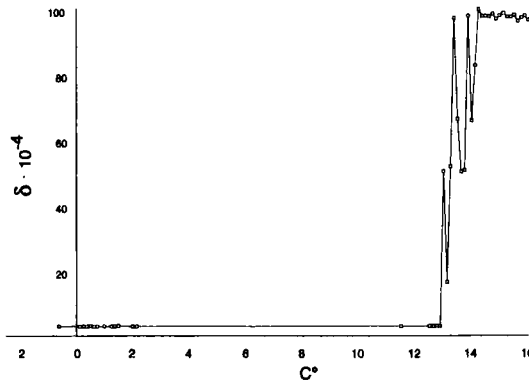
Figure 1   Logarithmic decrements of dampings of the viscometer containing the HgTl amalgam at 39.9% at. Tl versus temperature ($-1\,^\circ$C to $+15.625\,^\circ$C) in period 1 (05/04/1991–31/07/1991).
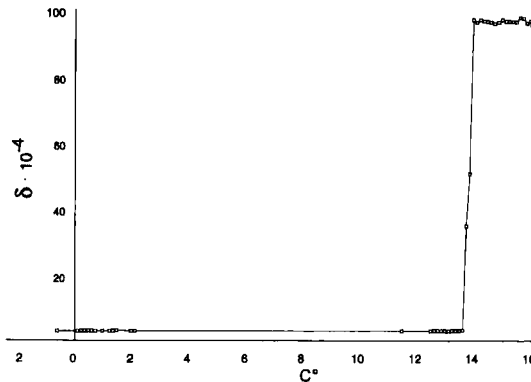
Figure 2   Logarithmic decrements of dampings of the viscometer containing the HgTl amalgam at 39.9% at. Tl versus temperature ($-1\,^\circ$C to $+15.625\,^\circ$C) in period 2 (01/08/1991–24/12/1991).
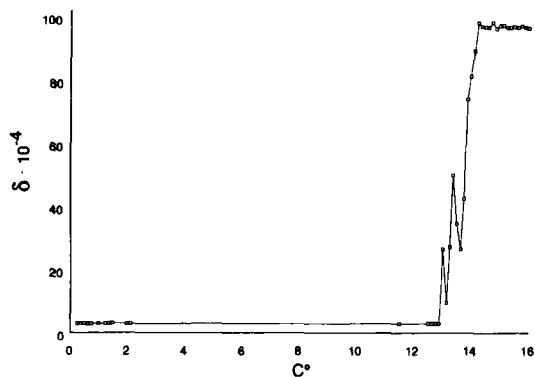
Figure 3 Mean values of logarithmic decrements of dampings of viscometer containing the HgTl 39.9% at. Tl versus temperature (-1 °C to $+15.625$ °C) recorded from 05/04/1991 to 24/12/1991.
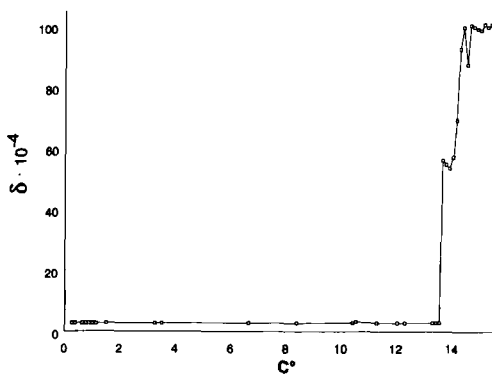

Figure 4 Mean values of logarithmic decrements of dampings of viscometer containing the HgTl 40% at. Tl versus temperature (-2 °C to $+15.625$ °C) recorded from 31/07/1990 to 09/05/1991.
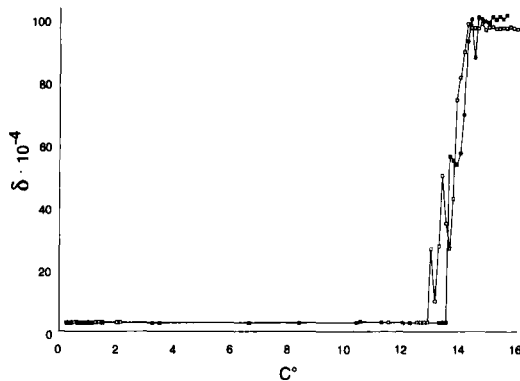
Figure 5 Comparison between mean values of logarithmic decrements of dampings calculated for HgTl analigam at 40% at. Tl (close squares) and at 39.9% at. Tl (open squares).

$\delta_2 = 2.9291190\cdot10^{-4}, \delta_{02} = \delta_{01} = 2.450750\cdot10^{-4}$ (Fig. 2). We may conclude that at this temperature the amalgam is completely solid and this is the eutectic temperature. The value of the eutectic is perfectly coincident in the two periods. These results are in accord with theoretical values $(T^*; \delta^*)$ obtained from Ref. 1

$$\delta_1^* = 2.640646\cdot10^{-4} \quad \Delta\delta_1 = 0.3\cdot10^{-4}$$

$$\delta_2^* = 2.640976\cdot10^{-4} \quad \Delta\delta_2 = 0.3\cdot10^{-4}$$

With regard to the HgTl amalgam at 39.9% at. Tl, we found the eutectic at 1.125 °C. When increasing the temperature from 12.875 °C to 14 °C, the logarithmic decrement is substantially identical in the two groups of experiments, but is reached in a different way. In the first set of experiments (05/04/1991–31/07/1991) the transition to the liquid state is more rapid, with minimum and maximum being at closer values of temperature (minimum: temperature = 12.875 °C; $\delta\cdot10^{-4} = 2.978250$; maximum: temperature = 13.87 °C; $\delta\cdot10^{-4} = 97.679687$), whereas in the latter (01/08/1991 –24/12/1991) it occurs more gradually (minimum: temperature = 13.125 °C; $\delta\cdot10^{-4} = 2.909639$; maximum: temperature = 14 °C; $\delta\cdot10^{-4} = 96.795113$). On the other hand, the liquid state is coincident.

Mean values of logarithmic decrements calculated for HgTl 39.9% at. Tl are coincident with those calculated for HgTl 40% at. Tl (Fig. 5). At the temperature of 1.125 °C we obtained $\delta_1 = 2.9291175\cdot10^{-4}$, $\delta_{01} = 2.450750\cdot10^{-4}$ and $\delta_2 = 2.7623\ 395\cdot10^{-4}$, $\delta_{02} = \delta_{01} = 2.450750\cdot10^{-4}$: we may conclude that at this temperature the amalgam is completely solid and this is the eutectic temperature. The values of the eutectic is perfectly coincident for both 39.9% at. Tl and 40% at. Tl amalgam.

When increasing the temperature from 12.875 °C to 14.375 °C the logarithmic decrement relevant to the two averages is substantially identical, but is reached in a different way. In the case of 39.9% at. Tl, the transition to the liquid state is more rapid, with minimum and maximum being at closer values of temperature (minimum: temperature = 12.875 °C; $\delta\cdot10^{-4} = 2.987434$; maximum: temperature = 14 °C; $\delta\cdot10^{-4} = 81.225936$), whereas for 49% at. Tl such transition occurs more gradually (minimum: temperature = 13.5 °C; $\delta\cdot10^{-4} = 2.951242$; maximum: temperature = 14.375 °C; $\delta\cdot10^{-4} = 99.804991$). On the other hand, the logarithmic decrements of the two amalgams are perfectly parallel. Values of logarithmic decrement calculated for 39.9% at. Tl always reach lower levels, thus being located, in the phase diagram, on the right side of those recorded for 40% at. Tl. Further experiments are in progress to explore the left side.

SUMMARY

The logarithmic decrement of the dampings of an oscillating viscometer in presence or absence (δ and δ_0, respectively) of the HgTl amalgam at 39.9% at. Tl has been investigated at different temperatures, ranging from -1 °C to $+15.625$ °C and in two different periods (05/04/1991–31/07/1991 and 01/08/1991–24/12/1991). We found that

the HgTl amalgam at 39.9% at. Tl is completely solid at the temperature of 1.125 °C, with $\delta = 2.9291150 \cdot 10^{-4}$ and $\delta_0 = 2.450750 \cdot 10^{-4}$ in the two different periods. The liquid state was coincident as well. When comparing 39.9% at. Tl and 40% at. Tl amalgams, values of the eutectic are perfectly coincident. In the phase diagram, the logarithmic decrement of the 39.9% at. Tl is located on the right side with respect to the 40% at. Tl.

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