dataphysics

DataPhysics Instruments GmbH Raiffeisenstraße 34·70794 Filderstadt, Germany
phone +49 (0)711 770556-0 ·fax +49 (0)711-770556-99
sales@dataphysics.de · www.dataphysics.de

Applikation Note 19

Determination of the surface tension of a soft solder and solder wire

Problem

A solder is defined as a metal alloy with metallic components, such as lead, silver or tin. Solders are generally used to connect alloys and metals like aluminium, bronze, gold, brass or zinc superficially by melting without heating the single parts up to their melting point. There are hard and soft solders. Latter shows a lower resistance against mechanical stress with a slumping temperature of smaller 450°C.

The present application note deals with the determination of the surface tensions of the soft solder Woodian metal (Bi50Pb25Cd12.5Sn12.5) – which is famous for its anomaly of extension during its setting equal to water – and solder wire Sn40Pb60 at different temperature levels and test specimen. Therefore, measurement device DCATxx and the heating chamber TEC250, both DataPhysics Instruments, were used.

Method

The surface tension of liquids can be measured with the Wilhelmy method by dipping a platinic-iridium-plate with specific geometry and velocity into a liquid. Then, the force of the lamella affecting the micro scales is determined. With complete wettability, the contact angle becomes 0°. So, the surface tension is calculated. But the application problem of using solders is that they cannot be measured with the standard platinic-iridium-plate, because the contact angle becomes >0°. Therefore, test specimens with different material are necessary.

Therefore, borosilicate glass (Borofloat 33 whiate, Fa. Schott) and quartz crystal glass (Fa. Roth, Art. Nr. H869) were used as specimen for the measurements with Woodian metal. Reaching a melting temperature from 120°C, the heating chamber TEC250 from Dataphysics Instruments was used.

First, the chamber was flushed out with nitrogen. Emerging oxidative layers could be removed with an integrated slag slider before the measurement started. Aceton was used to clean the glass panels, also.

Results

Using the Wilhelmy method to determine the surface tension, the glas panels showed different results in a range from 399-418 mN/m (Figure 1).

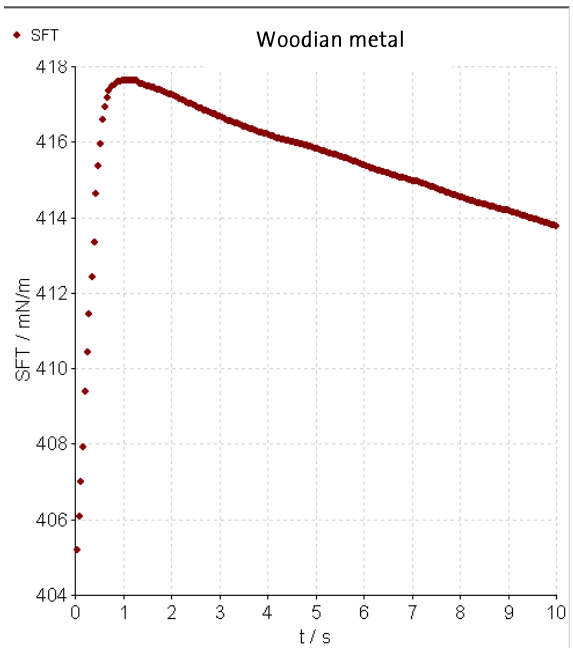

Figure 1: Curve of Woodian metal

Additionally, the glass panel made of quartz crystal was cleaned with sulfuric acid (30%). This could reduce the surface tension significantly (Tab.1). According to literature values[1] which have been

[1] Darot, M. & Reuschlé, T. (1999): Direct Assessment of Wood's Metal Wettability on Quartz – Pure appl. geophys. 155; p. 119-129.

reported 417-444 mN/m at 120°C, the results in the present experimental framework were lower.

Table 1: Surface tension of Woodian metal with two glass panels at 120°C.

Test specimen	Surface tension Woodian metal (Bi50Pb25Cd12.5Sn12.5)
Borosilicat glas	399 mN/m
Quartz crystal	418 mN/m
Quartz crystal (purified)	386 mN/m

In a second experiment, surface tension of solder wire Sn40Pb60 was measured by using copper plates at 250°C (Table 2).

Table 2

Test specimen	Surface tension solder wire Sn40Pb60
Copper plate (unpurified)	183 mN/m
Quartz crystal	96 mN/m
Quartz crystal (purified)	386 mN/m

The unpurified plate resulted in 183 mN/m. The quartz crystal glass panel (cleaned with acetone before use) resulted in a surface tension of only 96 mN/m. But its purification with nitric acid (30%) could increase the value to 301 mN/m. Nevertheless, the results could not confirm literature values[2] which have been reported a surface tension range of 475-510 mN/m.

A further measurement was done with different copper specimen (Table 3). The results ranged from 393 mN/m (uncleaned) to 490 mN/m (blanched copper plate + soldier wire Sn40Pb60). The curve of the experiment with solder wire can be seen in Figure 2. Repeating the measurement using the same plate again resulted only in a lower surface tension (402 mN/m).

[2]Keene, B. J. (1993): The Surface Tension of Tin and its Alloys with Particular Reference to Solders – National Physical Laboratory.

Table 3: Different specimen and its surface tension

Test specimen + solder	Surface tension
Copper plate (unpurified) + flux	393 mN/m
Copper plate (blanched) + solder	463 mN/m
Blanched copper plate + solder wire Sn40Pb60	490 mN/m
Repetition: Blanched copper plate + solder wire Sn40Pb60	402 mN/m

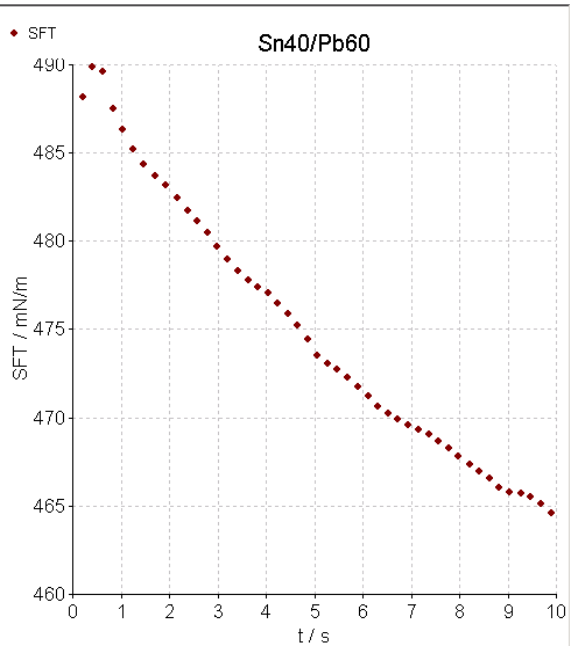

Fig. 2: Blanching measurement of solder wire Sn40Pb60 and coated copper plate

Conclusion

The surface tension of soft solder and solder wired was determined by the Wilhelmy method using the DCAT from DataPhysics Instruments.

All measurements showed a decline of the surface tension with proceeding experimental time. This can be explained by oxidative processes, because with further oxygen contact, a skin has been developed. But it has also to do with an increase of the contact angle according to the melting of the solder. For the evaluation, only peak values within obtained within the first measurement seconds were considered.