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**UV curable resin and thermosetting resin
— Continuous measurement method of
shrinkage rate**

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Foreword

This Japanese Industrial Standard has been established by the Minister of Economy, Trade and Industry, through deliberations at the Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law.

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UV curable resin and thermosetting resin — Continuous measurement method of shrinkage rate

1 Scope

This Japanese Industrial Standard specifies a method for continuously measuring the curing state of UV curable resin and/or thermosetting resin to determine the curing shrinkage rate.

This Standard is applicable to resin compositions that are in a liquid state prior to curing. It is also applicable to resins cured under both UV curing and heat curing conditions.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS K 6900 *Plastics — Vocabulary*

JIS K 7100 *Plastics — Standard atmospheres for conditioning and testing*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS K 6900**, and the following apply.

3.1

UV curable resin

resin such as acrylate resin and epoxy resin that is cured by exposure to UV radiation

3.2

thermosetting resin

resin such as acrylate resin and epoxy resin that is cured by heat

3.3

curing condition

condition for curing sample resins by UV irradiation and/or heating

3.4

curing shrinkage rate

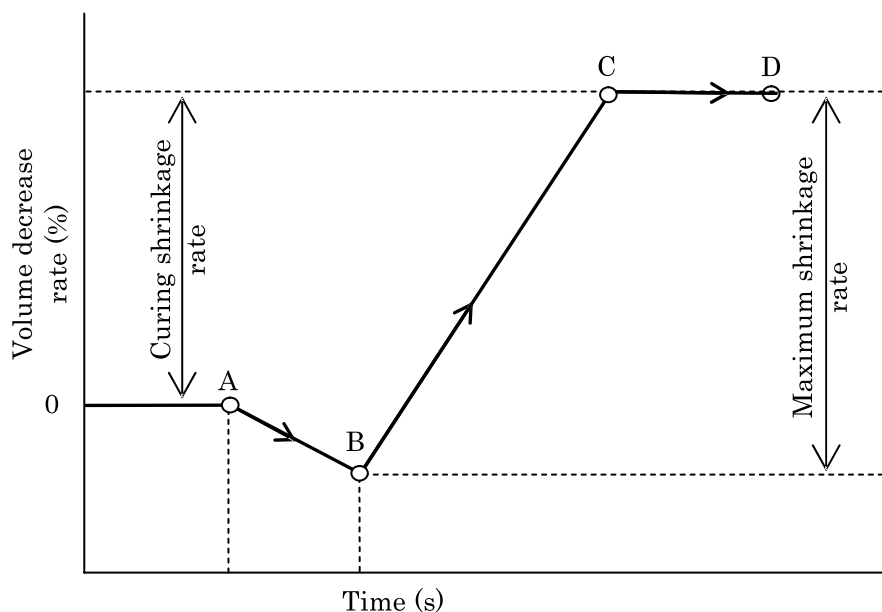
rate of resin volume after curing to the resin volume before curing (rate of shrinkage due to resin curing)

4 Principle

Curing is performed under the curing condition using a minute amount of sample of several millilitres or less, and then the film thickness change of resin before and after curing is continuously measured. From the decrease rate of the film thickness, the shrinkage rate is obtained. If curing is performed by keeping the same cross-sectional area of the sample in a container and changing the film thickness only, the decrease rate of film thickness will be proportional to the decrease rate of volume. This volume decrease rate is taken as curing shrinkage rate. In this method, the shrinkage due to resin curing is continuously measured by converting the change of film thickness. This method is effective for tracking the behaviour of sample volume, i.e. how the sample volume changes during UV irradiation, heating or cooling.

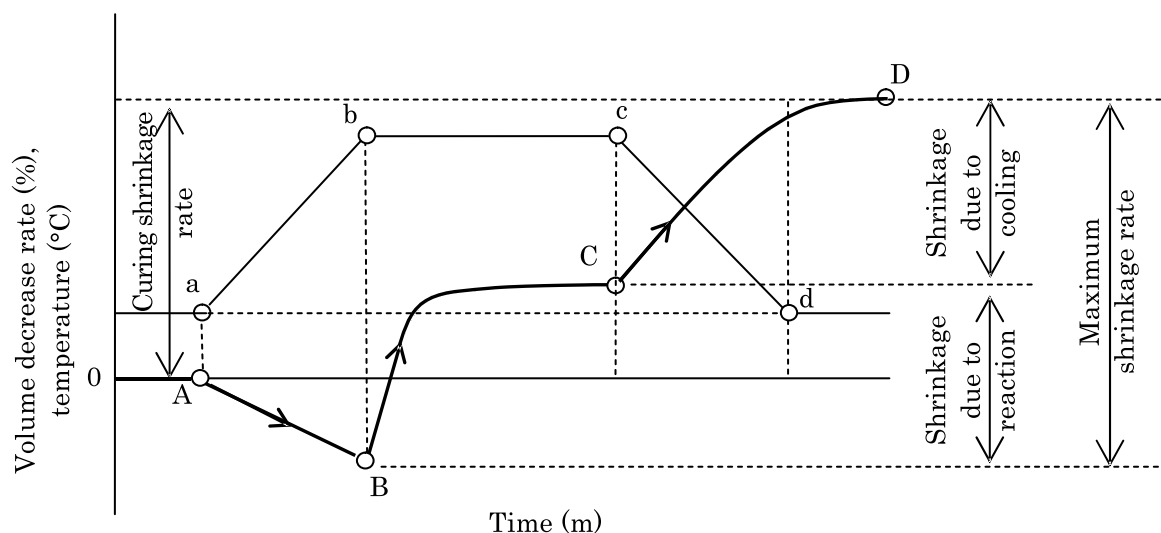
NOTE 1 When the UV curable resin is exposed to UV radiation, it expands immediately after irradiation and then shrinks as curing progresses (see Figure 1). For some resins that react or cure quickly, shrinkage starts immediately after irradiation (see Figure B.1).

NOTE 2 When the thermosetting resin is heated, it expands while the temperature of resin rises. Once heated to the curing temperature where curing starts, the resin starts to shrink and continues to shrink until it is cooled to room temperature (see Figure 2).



A : Irradiation start point
B : Curing start point
C : Curing end point
D : Shrinkage end point

Figure 1 Curing behaviour of UV curable resin



A : Heating start point Room temperature : a, d Curing temperature : b, c
 B : Curing start point
 C : Curing end point
 D : Shrinkage end point

Figure 2 Curing behaviour of thermosetting resin

5 Measurement method

5.1 Types of measurement method and measurement environment

5.1.1 Types of measurement method

There are three types of curing conditions, which are UV radiation curing, heat curing and the combination of these. A measurement method shall be selected according to the actual curing condition.

NOTE The use of curing conditions specified in other **JISs** makes it possible to compare with those. For example, when curing is performed under the conditions of time (48 h or 168 h) and temperature (80 °C or 110 °C) as specified in **JIS K 6911**, shrinkage rate can be compared with the rate of shrinkage on heating obtained by the conventional method.

5.1.2 Measurement environment

Unless otherwise specified, the condition of measurement chamber shall be of standard atmosphere Class 2 [temperature 23 °C ± 2 °C, humidity (50 ± 10) %] as specified in Clause 5 of **JIS K 7100**, and the sample measured (about 0.1 ml to 1.0 ml) at any temperature shall be cured under the curing condition where measurement is performed.

5.2 Sample

The sample shall be as follows.

- When the sample contains fine air bubbles, remove those bubbles beforehand by