



## Shrinkage Rate for Injection Molding of Sarlink Thermoplastic Elastomers

### 1. Introduction:

This report provides mold and post mold shrinkage data on Sarlink 3000, 4000, 5000, 6000 and high flow products.

It is known that there are numerous factors which affect shrinkage, for example, materials (hardness and viscosity, etc), part and tool design (geometry of the part, length and wall thickness of the part, runner style and gate type, size and position, etc), processing conditions (melt temperature, mold temperature, ram velocity and cooling time) etc. It is very important to note that this study does not encompass complete information regarding the effect of shrinkage on all processing parameters and designs. However, the data provided can be used as a basic guideline for construction of tools.

The mold shrinkage study is based on ISO 2577 standard and post shrinkage is based on Ford specifications (WSD-M2D 378-382).

### 2. Sample Preparation

#### Equipment

Materials were molded into a 100x100 x2.37 mm (4"x4') single cavity plaque mold. The gate was adjusted at the center position. Plaques were molded on a 55-ton injection-molding machine.

#### Processing Condition

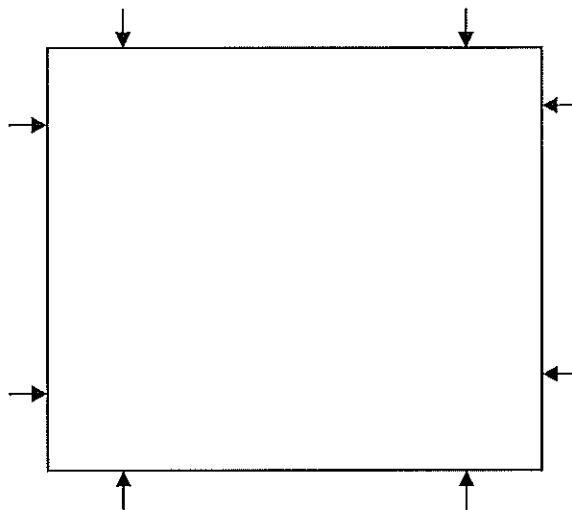
Melt temperature and mold temperature were set up at 400 °F and 100 °F, respectively. The injection pressures were slightly changed by grades. Other parameters, such as ram velocity, shot size and cooling time, etc, kept no change during the entire study.

### 3. Data generation

#### Mold Shrinkage (MS)

After removal from the mold, the test plaques were placed on the lab counter for 48 hours. The lab has temperature and humidity controlled at standard atmosphere with  $23 \pm 2^\circ\text{C}$  and humidity  $50 \pm 3\%$ .

A flat, 4"x4", test plaque was used for generating the shrinkage data. Two width and two length measurements were made on each plaque. These width and length measurements are made at distance of 20 mm from the corners. See Figure 1



Three test plaques were obtained from random samples saved from each molding. Every shrinkage datum, length or width, was averaged from six readings (2 readings/each plaque x 3 test plaques)

The mold shrinkage (*MS*), mm/mm in length and width is calculated by the following formula,

$$\text{Length } MS_{48h} = (L_0 - L_1) / L_0$$

$$\text{Width } MS_{48h} = (W_0 - W_1) / W_0$$

$L_0$  and  $W_0$  are the length and width, in millimeters, of the dimensions of the mold.

$L_1$  and  $W_1$  are the length and width, in millimeters, of the corresponding dimensions measured on the test plaques.

### Post Mold Shrinkage (PS)

Post shrinkage data were generated based on Ford specifications, annealing at 110+/- 2 °C for 48 hours, following by three hours cooling at standard atmosphere.

The percentage of the post shrinkage (PS), is calculated by the following formula,

$$\text{Length } PS_{48h} \% = (L_1 - L_2) / L_1 \times 100$$

$$\text{Width } PS_{48h} \% = (W_1 - W_2) / W_1 \times 100$$

$L_2$  and  $W_2$  are the length and width, in millimeters, of the same dimensions of the tested plaque ( $L_1$  and  $W_1$ ), measured after heat treatment for 48 hours and subsequent storage for 3 hours at standard atmosphere.

The post shrinkage data were given by range from six readings.

## **4. Results**

Table 1 Sarlink 3000 Mold Shrinkage Data - mm/mm (in/in)

Table 2 Sarlink 3000 Post Mold Shrinkage Data - mm/mm (in/in)

Table 3 Sarlink 4000 Mold Shrinkage Data - mm/mm (in/in)

Table 4 Sarlink 4000 Post Mold Shrinkage Data - mm/mm (in/in)

Table 5 Sarlink 5000 and High Flow Shrinkage Data - mm/mm (in/in)

Table 6 Sarlink 5000 and High Flow Post Mold Shrinkage Data - mm/mm (in/in)

Table 7 Sarlink 6000 Post Mold Shrinkage Data - mm/mm (in/in)

## 5. Conclusions

The following generalizations are made based on the data shown in Table 1 to Table 7.

1. The mold shrinkage (in length and in width) of all Sarlink products are in range of 0.011 mm/mm to 0.023 mm/mm, which are 1.1% to 2.3%.
2. The post shrinkage of all Sarlink products is below 0.5%.
3. Greater shrinkage is observed with lower hardness grades, especially Shore A 35, 45 and 55 grades.
4. The differences in shrinkage between length and width were also observed in the lower hardness grades. As hardness increases, the difference is not significant.
5. In Sarlink 3000 series, 3140-04 has much higher shrinkage rate than others.

**Table 1**

**Sarlink 3000 Mold Shrinkage Data - mm/mm (in/in)**

Grades	<u>400°F (204 °C) Melt and 100°F (37°C) mold temperature</u> <u>Averages after 48 hours</u>	
	<b>Length</b>	<b>Width</b>
3135N	0.021	0.016
3140N	0.018	0.014
3140N-04	0.023	0.017
3150N	0.013	0.013
3160N	0.013	0.013
3170N	0.012	0.012
3180N	0.011	0.011
3190N	0.013	0.013
3139DN	0.013	0.013
3145DN	0.014	0.014

**Table 2**

**Sarlink 3000 Post Mold Shrinkage Data - %**

Grades     Annealing at 110 C °C for 48 hours and subsequent storage  
for 3 hours at standard atmosphere

	<b><u>Length%</u></b>	<b><u>Width%</u></b>
<u>3135N</u>	<u>0.1-0.3</u>	<u>0.1-0.35</u>
<u>3140N</u>	<u>0.1-0.25</u>	<u>0.2-0.4</u>
<u>3140N-04</u>	<u>0.3-0.5</u>	<u>0.3-0.45</u>
<u>3150N</u>	<u>0.1-0.35</u>	<u>0.1-0.25</u>
<u>3160N</u>	<u>0.2-0.3</u>	<u>0.1-0.25</u>
<u>3170N</u>	<u>0.2-0.3</u>	<u>0.2-0.3</u>
<u>3180N</u>	<u>0.3-0.4</u>	<u>0.2-0.35</u>
<u>3190N</u>	<u>0.3-0.4</u>	<u>0.2-0.35</u>
<u>3139DN</u>	<u>0.2-0.3</u>	<u>0.2-0.3</u>
<u>3145DN</u>	<u>0.15-0.22</u>	<u>0.2-0.3</u>

**Table 3**

**Sarlink 4000 Mold Shrinkage Data - mm/mm (in/in)**

Grades	<u>400°F (204 °C) Melt and 100°F (37°C) mold temperature</u>	
	<u>Averages after 48 hours</u>	
	<b>Length</b>	<b>Width</b>
4145B	0.021	0.016
4155B	0.017	0.014
4165B	0.013	0.013
4175B	0.012	0.012
4180B	0.012	0.011
4190B	0.012	0.012
4139DB	0.013	0.013
4149DB	0.014	0.015

**Table 4**

**Sarlink 4000 Post Mold Shrinkage Data - %**

Grades Annealing at 110 C °C for 48 hours and subsequent storage  
for 3 hours at standard atmosphere

	<b>Length%</b>	<b>Width%</b>
4145B	0.2-0.45	0.2-0.4
4155B	0.2-0.35	0.2-0.3
4165B	0.1-0.2	0.1-0.2
4175B	0.1-0.25	0.1-0.25
4180B	0.1-0.25	0.1-0.2
4190B	0.2-0.3	0.1-0.2
4139DB	0.1-0.25	0.1-0.2
4149DB	0-0.15	0-0.15

**Table 5**

**Sarlink 5000 and High Flow Grade Mold Shrinkage Data - mm/mm (in/in)**

Grades 400°F (204 °C) Melt and 100°F (37°C) mold temperature  
Averages after 48 hours

	<b>Length</b>	<b>Width</b>
5755B4	0.016	0.014
5765B4	0.015	0.013
5775B4	0.013	0.012
4765B-40B	0.016	0.015
10060B	0.014	0.014

**Table 6**

**Sarlink 5000 and High Flow Grade Post Mold Shrinkage Data - %**

Grades Annealing at 110 C °C for 48 hours and subsequent storage  
for 3 hours at standard atmosphere

	<b>Length%</b>	<b>Width%</b>
5755B4	0.2-0.3	0.2-0.3
5765B4	0.1-0.25	0.1-0.3
5775B4	0.2-0.35	0.2-0.35
4665B-40	0.2-0.3	0.15-0.3

**Table 7**

**Sarlink 6000 Mold Shrinkage Data - mm/mm (in/in)**

Grades 400°F (204 °C) Melt and 100°F (37°C) mold temperature  
Averages after 48 hours

	<b>Length</b>	<b>Width</b>
6135N	0.017	0.015
6145N	0.016	0.014
6155N	0.015	0.014
6165N-03	0.013	0.012
6180N	0.013	0.012