

**SPECIFICATION D-PN-6  
DICES OF THERMOELECTRIC MATERIAL**

1 Scope

This document covers requirements for P- and N-type dices made from thermoelectric (TE) materials with square or hexagonal cross section.

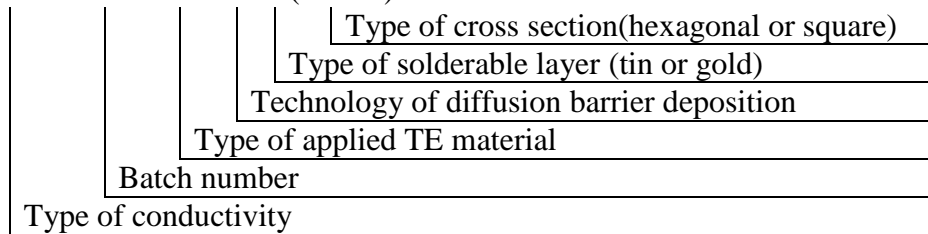
2 Applicable documents

- Each dice batch is given an “identification number”. A batch and its identification number, is defined by the following:
  - all dices are produced from TE material fabricated by the same technology and equipment
  - the process and equipment used during slicing and dicing is consistent for all dices in a batch;
  - the process and equipment used during the deposition of diffusion barriers and solderable layer is consistent for all dice in a batch
- all dices have resistivity from the same resistivity interval

3 Designations (ID#)

3.1 Each batch of dices is marked by “identification number” (ID#), which contains information about type of conductivity, batch number of the TE materials, technologies applied for deposition of diffusion barrier and solderable layer, and the types of metal alloys applied

P - XXXX – R XX T (H or S)



3.1 There are two variants for dice fabrication:

- hexagonal cross section (ID# suffix “H”)
- square cross section (ID# suffix S)

3.3 There are three variants for solderable layer plating:

- T – tin based alloy
- G – gold flash
- N – none (without solderable layer)

3.4 Type of TE material is defined by working temperature of module, for example

- C – cryogenic temperatures
- L – low temperatures
- R – room temperatures
- E – elevated temperatures
- G – generating material

4 Requirements

4.1 Height – more than 0,2 mm, accuracy (for semiconductor material)  $\pm 15 \mu\text{m}$

4.2 Cross section - more than 0,2 mm, accuracy  $\pm 15 \mu\text{m}$

4.3 Diffusion barrier (Ni based alloys) –  $7 \mu\text{m} \pm 2 \mu\text{m}$

4.4 Solderable layer (Sn based alloys) –  $7 \mu\text{m} \pm 2 \mu\text{m}$ , gold (Au) not more 0,2  $\mu\text{m}$

4.5 Adhesion – no less 1  $\text{kg}/\text{mm}^2$

4.6 The interval of electrical resistivity of applied TE material for one batch of dices is limited by increments of 0,050 milliohm-cm. For example, for room temperature material (R) resistivity interval is to be binned into 6 groups:

- 0,850-0,900 milliohm-cm;
- 0,900-0,950 milliohm-cm;
- 0,950-1,000 milliohm-cm;
- 1,000-1,050 milliohm-cm;
- 1,050-1,100 milliohm-cm;
- 1,100-1,150 milliohm-cm;

for generating material (G) resistivity interval is to be binned into 3 groups:

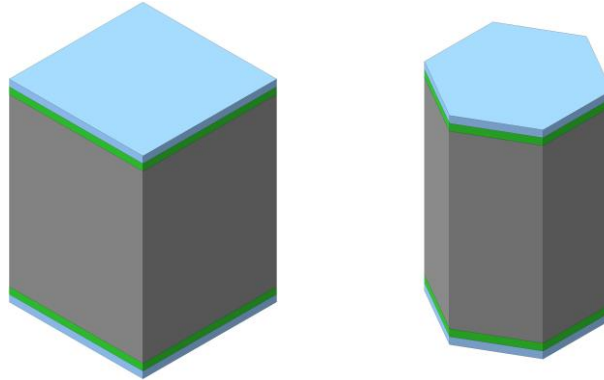
- 0.700-0.750 milliohm-cm;
- 0.750-0.800 milliohm-cm;
- 0.800-0.850 milliohm-cm;

4.7 In accordance with the requirements, a test report is drawn up for each batch (see Appendix 4).

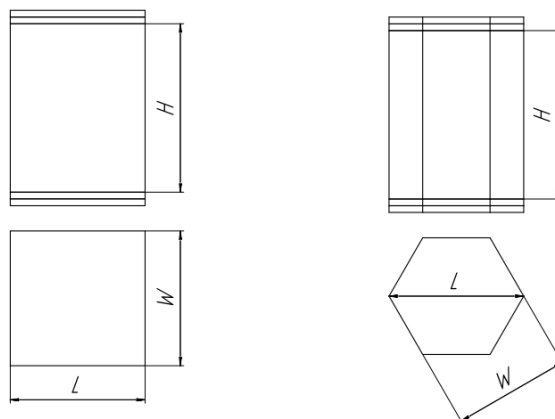
A test report is provided at the request of the Customer

## 5 Appearance

- Dices can be square and hexagonal shape



- Smooth silver-gray surface finish
- No pits or grooves
- No ridges
- No scratches
- No chips, pits or voids
- A burr is allowed on one side's edge of the dices; the width of burr must not exceed 0.03 mm.
- Drawing:



## 6 Traceability

- Traceability to the process conditions is provided by records in the "Traveler" (see Appendix 1). Time for maintaining these records must be agreed with a Customer.

## 7 Packaging

7.1 P-and N-type dices are packed separately in vacuum sealed plastic bags, which are placed in plastic containers.

7.2 A label is attached to the container and to the plastic bag containing the following information:

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- identification number
- size of dices
- weight

7.3 Containers are marked by color dot or paper dot with number to indicate resistivity as follows:

Room temperatures:

Black	– 0.851-0.900 milliohm-cm,
Blue	– 0.900-0.950 milliohm-cm,
Green	– 0.950-1.000 milliohm-cm,
Yellow	– 1.000-1.050 milliohm-cm,
Red	– 1.050-1.100 milliohm-cm,
White	– 1.100-1.150 milliohm-cm.

Generating material:

№1	– 0.700-0.750 milliohm-cm;
№2	– 0.750-0.800 milliohm-cm;
№3	– 0.800-0.850 milliohm-cm;

7.3 Containers with dices are packed in a carton box (see Appendix 2), a certificates are put into the box (see Appendix 3)

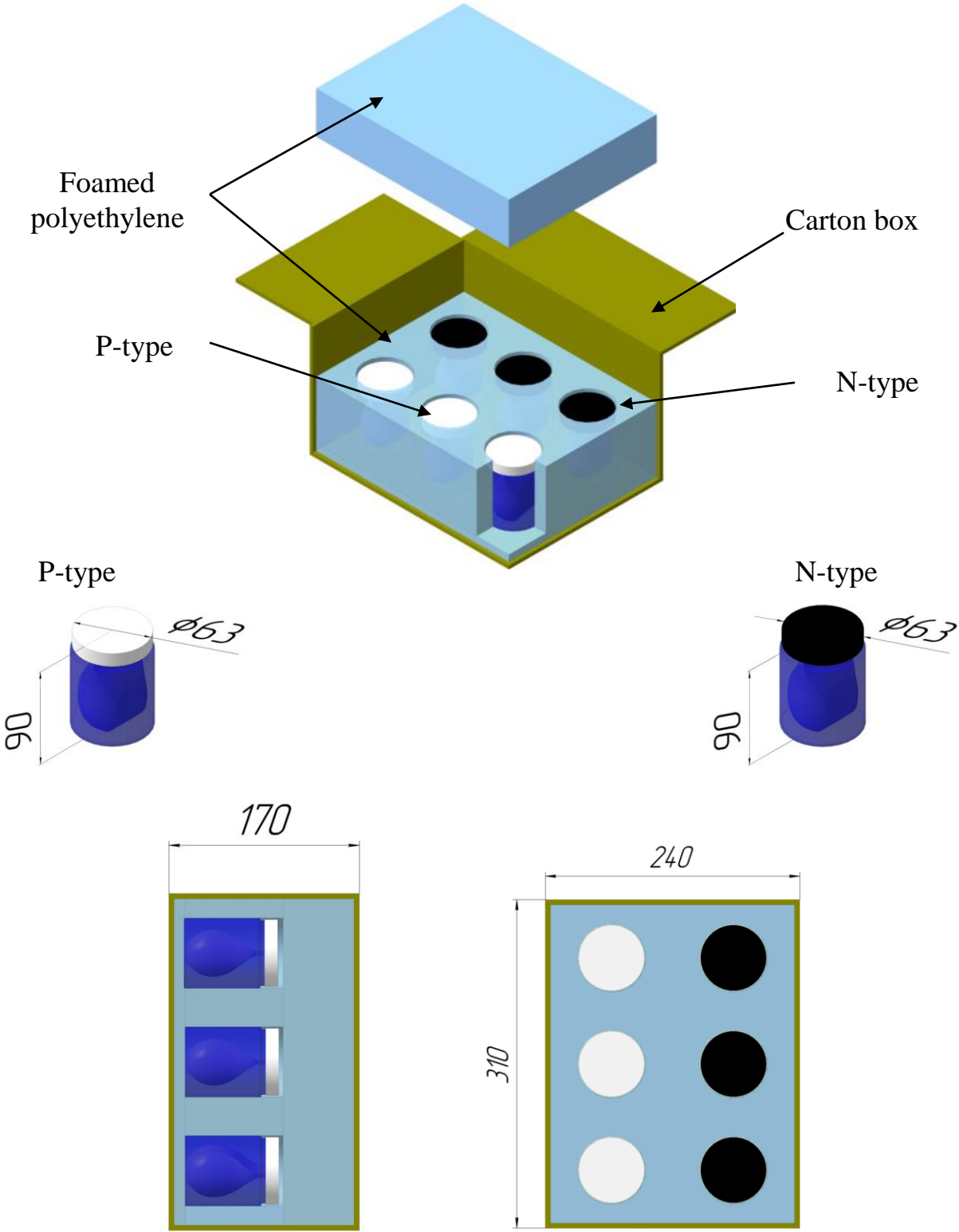
8 Shipping boxes are labeled with the following information:

- Name of a Sender
  - Name and address of a Consignee
  - Description of a goods (TE dices)
  - Purchase Order Number
  - Net Weight/Gross Weight
-

## Карта сопровождения (Traveler) (термоэлектрические ветви/ dices of thermoelectric material)

Номер процесса синтеза/ synthesis process number		Диапазон электропроводности при 25 °C /Conductivity at 25 °C, interval		
Станок/ machine tool	<b>Номер процесса резки на шайбы/ Slicing number</b>		Дата/ date	Исполнитель/ executor
Резка шайб / slicing	Толщина шайб/ slices thickness			
	Промывка/ cleaning			
	Количество шайб/ Number of slices			
	Масса шайб/ Mass of slices			
Нанесение покрытия/ Plating	Толщина диффузионного слоя Ni/ Ni diffusion barrier thickness			
	Количество слоев/ Number of layers			
	Толщина паячного слоя Sn(Au)/ Sn(Au) solderable layer thickness			
	Количество шайб/ Number of slices			
	Масса шайб/ Mass of slices			
Контроль типа проводимости/ Type conductivity control				
Станок/ machine tool	<b>Номер процесса резки на ветви/ Dicing number</b>			
Резка ветвей/ Dicing	Размер сечения/Cross section size			
	Масса ветвей/ Mass of dices			
Адгезия/ adhesion				

# PACKAGE



(Sample)

Appendix 3

# CERTIFICATE 01

for dices of  $\text{Bi}_2\text{Te}_3\text{-Bi}_2\text{Se}_3$

- |  |                                     |
|--|-------------------------------------|
| 1. Type of conductivity                          | – N-type                            |
| 2. Method of fabrication for TE material         | – extrusion                         |
| 4. Type of shape                                 | – hexagonal                         |
| 5. Dice dimensions (H×W×L)                       | – 2,00×1,72×1,99                    |
| 6. Diffusion barrier                             | – Ni-based alloy                    |
| 7. Solderable layer                              | – tin-based alloy (m. p. t. 230 °C) |
| 8. Adhesion                                      | – no less 1 kg/mm <sup>2</sup>      |
| 9. Resistivity at 25 <sup>0</sup> C, total range | – 0.851-1.150 (milliohm-cm)         |
|  | Black – 0.851-0.900 milliohm-cm,    |
|  | Blue – 0.900-0.950 milliohm-cm,     |
|  | Green – 0.950-1.000 milliohm-cm,    |
| 10. Marking of containers by color:              | Yellow – 1.000-1.050 milliohm-cm,   |
|  | Red – 1.050-1.100 milliohm-cm,      |
|  | White – 1.100-1.150 milliohm-cm.    |

RoHS compliant product

Number of containers with dices \_\_\_\_\_

Net weight, gr \_\_\_\_\_

Date \_\_\_\_\_

QC manager \_\_\_\_\_

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(Sample)

Appendix 3

# CERTIFICATE 01

for dices of  $\text{Bi}_2\text{Te}_3\text{-Sb}_2\text{Te}_3$

- |  |                                     |
|--|-------------------------------------|
| 1. Type of conductivity                          | – P-type                            |
| 2. Method of fabrication for TE material         | – extrusion                         |
| 4. Type of shape                                 | – hexagonal                         |
| 5. Dice dimensions (H×W×L)                       | – 2,00×1,72×1,99                    |
| 6. Diffusion barrier                             | – Ni-based alloy                    |
| 7. Solderable layer                              | – tin-based alloy (m. p. t. 230 °C) |
| 8. Adhesion                                      | – no less 1 kg/mm <sup>2</sup>      |
| 9. Resistivity at 25 <sup>0</sup> C, total range | – 0.851-1.150 (milliohm-cm)         |
|  | Black – 0.851-0.900 milliohm-cm,    |
|  | Blue – 0.900-0.950 milliohm-cm,     |
|  | Green – 0.950-1.000 milliohm-cm,    |
| 10. Marking of containers by color marker:       | Yellow – 1.000-1.050 milliohm-cm,   |
|  | Red – 1.050-1.100 milliohm-cm,      |
|  | White – 1.100-1.150 milliohm-cm.    |

RoHS compliant product

Number of containers with dices \_\_\_\_\_

Net weight, gr \_\_\_\_\_

Date \_\_\_\_\_

QC manager \_\_\_\_\_

(Sample)

Appendix 4

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**Test report P-0015-R02T**

<b>Parameter</b>	<b>Requirement</b>	<b>Test results</b>
Slice thickness	2,00 mm $\pm$ 0,015 mm	correspond
Ni diffusion barrier thickness	7 $\mu\text{m}$ $\pm$ 2 $\mu\text{m}$	correspond
Sn solderable layer thickness	7 $\mu\text{m}$ $\pm$ 2 $\mu\text{m}$	correspond
Cross section size	1,60 mm $\pm$ 0,015 mm	correspond
The interval of electrical conductivity at 25 °C	1000-1053 1/(Ohm·cm)	correspond
Adhesion	more 1 kg/mm <sup>2</sup>	correspond

Date \_\_\_\_\_

QC \_\_\_\_\_