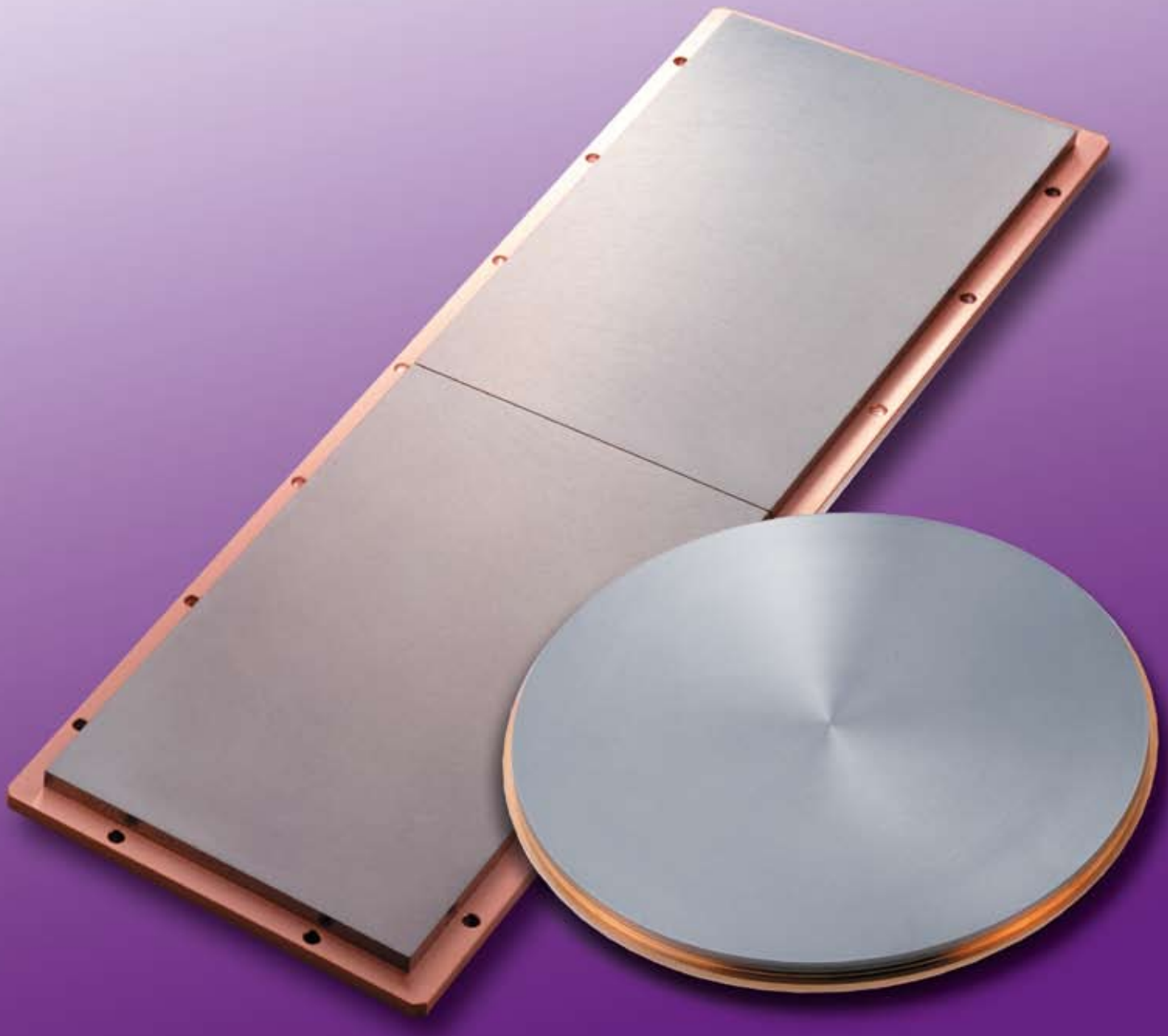
Sputtering Targets for Thin Film Thermo-Electrics

umicore



Umicore Thin Film Products

Umicore Thin Film Products, a globally active business unit within the Umicore Group, is one of the leading producers of coating materials for physical vapor deposition with more than 50 years experience in this field. Its Semiconductor portfolio covers a wide range of highly effective sputtering targets and evaporation materials.

Thermo-electricity is the conversion of temperature differences to electric voltage (thermo-electric generator) resp. the conversion of electric voltage to temperature difference (thermo-electric cooler). While all materials have some thermo-electric properties, thermo-electric materials exhibit a unique combination of high thermo-power, high electrical conductivity and low thermal conductivity.

With the development of Energy Harvesting and Wireless Sensor Networks small form factor has become an essential device feature. Thin film thermo-electric devices offer the best compromise between size and performance.

Typical thermo-electric materials for applications below 150°C are semiconducting tellurides like Bi_2Te_3 (n-type) and Sb_2Te_3 (p-type). Selected doping with other chalcogenides like S, Se and Sb improves the thermo-electric properties.

Based on their experience with chalcogenide materials for optical data storage and non-volatile phase change RAM, Umicore offer sputtering target of thermo-electric tellurides with up to 5 elements.

For new applications at higher temperatures a large variety of materials can be looked at. The figure displays the temperature behaviour of several thermo-electric materials.

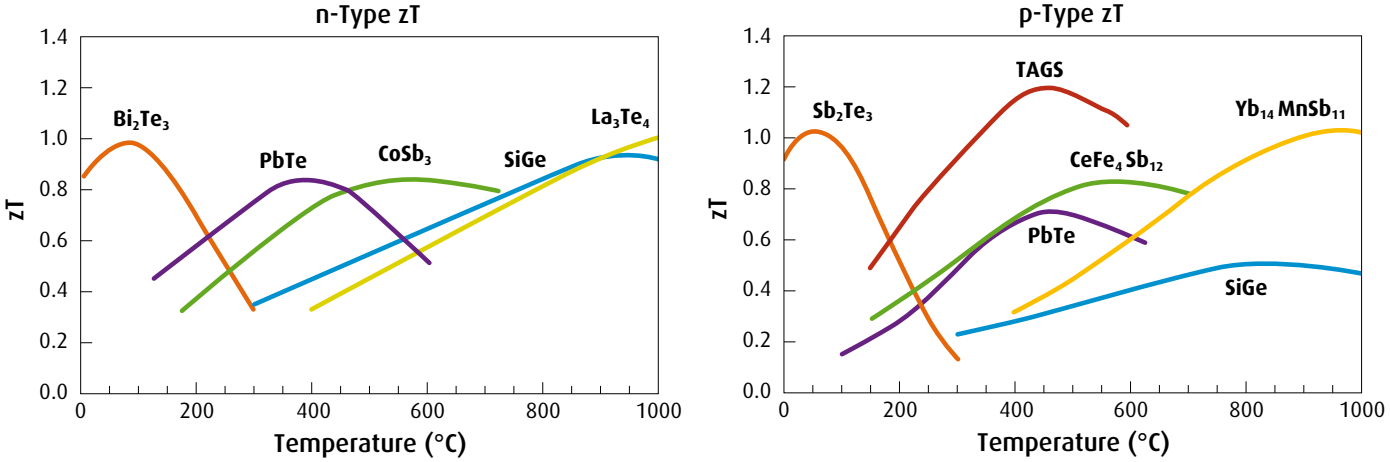


Figure of merit zT vs. temperature

Bi_2Te_3 (n-type) and Sb_2Te_2 (p-type) with selected doping for improved thermo-electric properties

Production process

Sputtering targets of thermo-electric materials are produced by powder metallurgy. Powders are prepared by alloy melting of the raw materials and subsequent milling. Then powders are processed to discs using the most appropriate pressing technology like Hot Pressing (HP) or Hot Isostatic Pressing (HIP).

Analysis

Final materials are tested in our leading edge analytical laboratory or one of our associate laboratories:

- Hot gas extraction (LECO)
- Differential thermo-analysis (DTA) combined with thermogravimetry (TG)
- Glow discharge mass spectrometry (GDMS)
- X-ray fluorescence analysis (XRF)
- X-ray diffraction (XRD)
- Metallographic investigation
- Density measurement (Archimedes principle)

Microstructure

Fine grain microstructure is a key factor influencing the sputtering behavior of a target and the uniformity of the sputtered layer. Our fine grade distribution is a result of several years of practical experience in the field of Phase Change Alloys for optical data storage and semiconductor applications. The grain distribution of a (Sb, Se) doped BiTe alloy is displayed on the micrograph.

Composition

We are able to produce thermo-electric materials with a very high reproducible composition due to extensive thermodynamical investigations and to the strict control of our production process. Quantification of alloying elements is done by calibrated XRF- or LA-ICP-MS-measurements. We guarantee the composition with a precision of ± 0.5 wt% on each element.

Purity

Using our standard raw materials and production process we offer standard 4N metallic purity. For extreme demanding applications, high purity levels are available upon request.

Trace Impurities

A selection of guaranteed impurity values is listed above

Element	Guaranteed (ppm)
Al	< 5
As	< 10
Ca	< 5
Cd	< 1
Cu	< 5
Fe	< 5
Ge	< 10
Mg	< 1
Mn	< 1
Na	< 5
Ni	< 5
Pb	< 1
Si	< 5
Zn	< 5
O	< 1000
Sum of metal impurities	< 100

Dimensions

Due to our flexible production processes different target sizes (up to Ø 450 mm single piece) and shapes can be produced.

Bonding

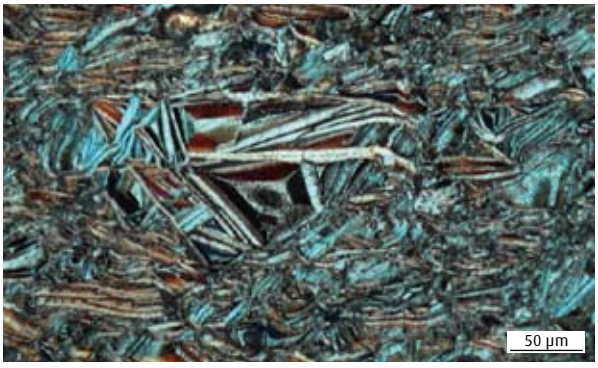
Umicore Thin Film Products uses its own proprietary bonding method, based on a flux-free solder technique. Thin film adhesion and diffusion barrier layers are applied to the back of each target, followed by a temperature controlled metallic solder seal between target and backing plate. The bonding is compliant to accommodate mechanical and thermal stress.

Packaging

Final cleaning and packaging is completed under clean room conditions. All targets are vacuum sealed in argon-filled polyethylene bags, guaranteeing consistent target performance, even when stored for a longer period of time.

Quality Assurance

The Balzers location is certified according to ISO 9001:2000, ISO 14001:2004 and OHSAS 18001:1999 standards. Other production sites are also ISO 9001:2000 certified. Documentation, process specifications, traceability, sophisticated analytical methods, and continuously trained employees guarantee the highest and most consistent product reliability.



Micrograph of the grain structure of (Sb, Se) doped BiTe

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Please find your local sales partner at:
www.tfp.umicore.com

Umicore Thin Film Products AG
Headquarter
Alte Landstrasse 8
9496 Balzers
Principality of Liechtenstein
Tel +423 388 7300
Fax +423 388 7450
sales.materials@umicore.com

Umicore Optical Materials
USA Inc.
2976 S. 614 Road
Quapaw, OK 74363
USA
Tel +1 918 673 1650
Fax +1 918 673 2121
sales.materials.us@umicore.com

Umicore Thin Film Products
Taiwan Co., Ltd.
No. 22, Aly. 4, Ln. 711 Boʻai St.,
Zhubei City, Hsinchu County 302
Taiwan
Tel +886 3553 2999
Fax +8863553 2525
sales.materals.hc@umicore.com