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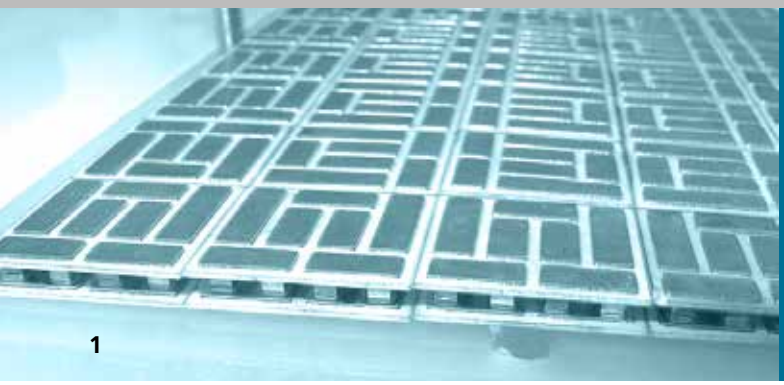
FRAUNHOFER INSTITUTE FOR PHYSICAL MEASUREMENT TECHNIQUES IPM



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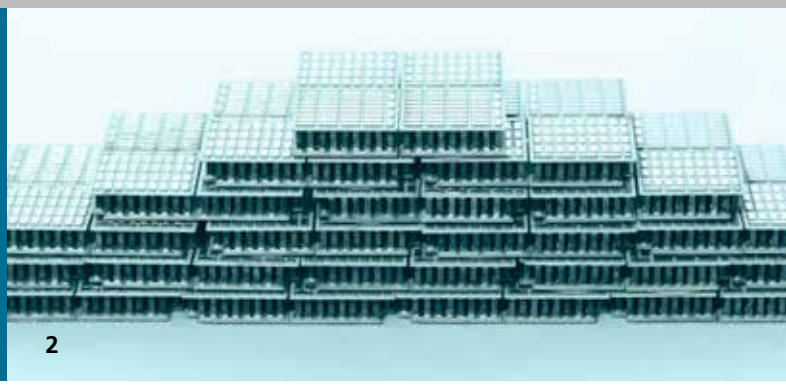

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1 *High-temperature thermoelectric modules (TEM).*
2 *TEM based on half-Heusler alloys. The module can be deployed at temperatures of up to 550 °C.*

HALF-HEUSLER MODULES

THERMOELECTRIC HIGH TEMPERATURE MODULES BASED ON HALF-HEUSLER-ALLOYS

Converting lost heat energy into electricity – this is what Fraunhofer IPM achieves with the aid of thermoelectric generators (TEG): Thermoelectric waste heat recovery is one of the most promising technologies to convert waste heat into electrical energy.

Efficient waste heat recovery

The core parts of such TEG systems are the newly developed thermoelectric modules which are based on half-Heusler alloys. They can be deployed at hot side temperatures of up to 550 °C, which corresponds to an exhaust gas temperature of up to 900 °C. Fraunhofer IPM has installed a semi-automatic module fabrication for this type of thermoelectric modules in order to develop TEG demonstrators and prototype waste heat recovery systems. First tests have shown a conversion efficiency of 5.4 % with an output power of ~1.4 W/cm².

From custom tailored modules to complete systems

Fraunhofer IPM offers the individual adjustment of the thermal and electrical design parameters (thermal and electrical load matching) in order to obtain the best possible output for each application. Table 1 (see reverse) shows the properties of a selection of fabricated thermoelectric modules based on half-Heusler alloys. Fraunhofer IPM assists in the design and development of complete waste heat recovery systems and provides custom tailored thermoelectric modules in sufficient quantities.

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Half-Heusler modules – Customized TE module designs

TEM properties		Unit	IPM-Type 1	IPM-Type 2	IPM-Type 3	IPM-Type 4	IPM-Type 5
TE module dimensions	Base area	[mm²]	16±0.5 × 16±0.5	16±0.5 × 16±0.5	16±0.5 × 16±0.5	16±0.5 × 16±0.5	16±0.5 × 16±0.5
	Height	[mm]	5.0±0.15	5.0±0.15	4.0±0.15	3.5±0.15	5.0±0.15
Weight (without wires)		[g]	~4	~3	~3	~2	~4
Number of thermocouples		[#]	7	7	7	7	39
Wire with thermal isolation ~80 mm long			500 mm long; blue: minus, red: plus				
Internal resistance at room temperature (without wires)		[Ohm]	0.04±0.01	0.06±0.01	0.03±0.01	0.05±0.01	1.4±0.1
Following module properties were achieved under the conditions ΔT ~530 K; T_{hot} ~550°C; T_{cold} ~20°C; p_{con} = 2 MPa, atmosphere: nitrogen							
Thermal resistance (K_{th})*		[K/W]	~9	~7	~7	~9	~8
Open circuit voltage (U_0)		[V]	1.0±0.1	1.0±0.1	0.9±0.1	1.0±0.1	5.3±0.5
Internal resistance (R_i)		[Ohm]	0.07±0.01	0.10±0.01	0.05±0.01	0.08±0.01	2.0±0.1
Power (P_{max})		[W]	3.1±0.3	2.4±0.2	3.5±0.3	3.0±0.3	3.5±0.3
Efficiency (η)*		[%]	~5.3	~3.2	~4.6	~5.1	~5.3

**Calculated data*