PROSPECTS FOR A BROADENED USE OF THERMOELECTRICS IN VEHICLES

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BSST

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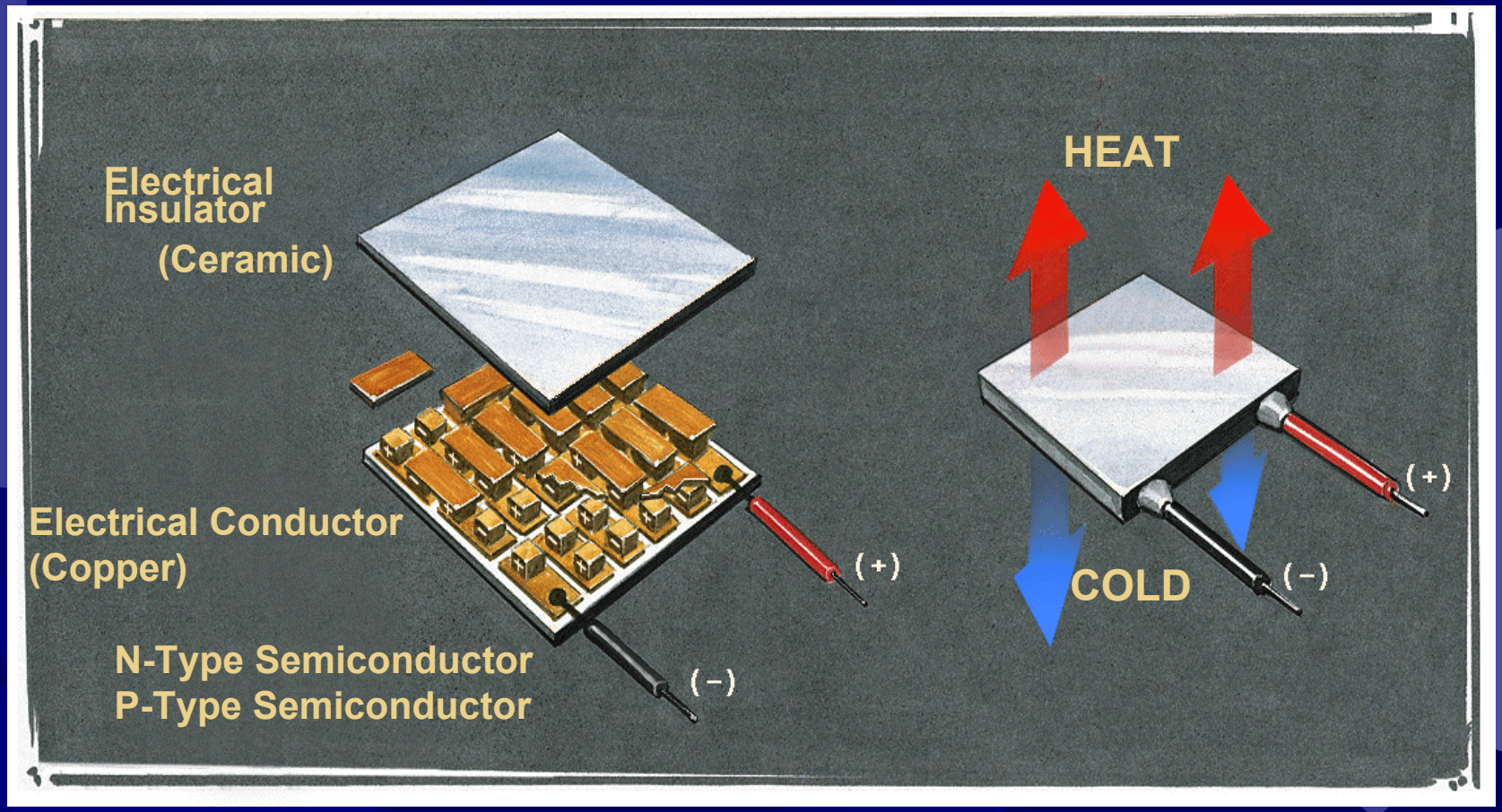
Thermoelectric Device



Why Thermoelectrics?

Solid-state cooling, heating and power generation

Small, light-weight and potentially very rugged

Very few (or no) moving parts

Electric-powered

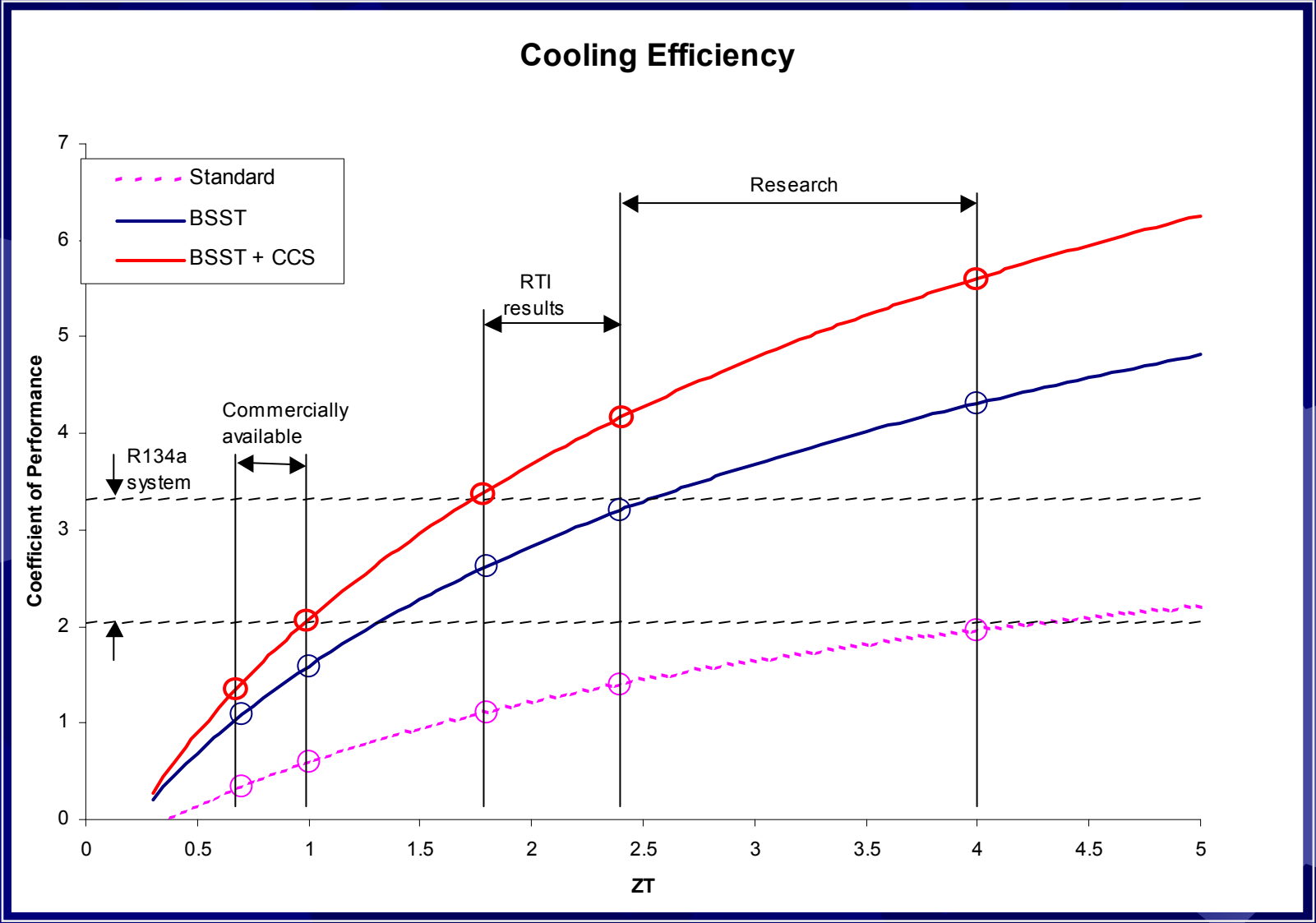
Contributes to efficiency gains and pollution reduction

Distributed cooling/heating/temperature control

Primary Sources of TE system Performance of Gains

Materials	
BiTe Thermoelectrics (1990s)	Baseline
Hetrostructure (2000-2002)	+70 to 160%
Thermodynamic Cycle	
Isolated Element (2000-2002)	100 to 120%
Convection (2001-2002)	30 to 80%
Materials/Design	
Incremental improvements (1960-2002)	5 to 15%
New ancillary materials and components (1960-2002)	5 to 10%

Advanced TE Performance



Opportunities for TEs in Vehicles

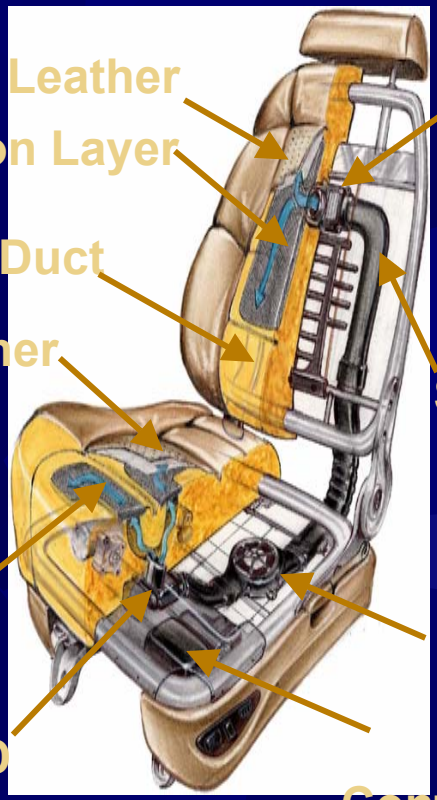
Cooling/Heating	Today	Today + BSST	Today + RTI	Today + RTI + BSST	ZT4 + BSST
Seat cooler/heater	OK	+	+	+	+
Refrigerator/cup cooler/heater		OK	OK	+	+
Personal climate control		OK	OK	+	+
Defrost/demist		OK	OK	+	+
Quiet /auxiliary HVAC (campers/vans/trucks)		OK	OK	+	+
HVAC (small diesels)		OK		+	+
HVAC (hybrid/electric/fuel cell vehicles)		Pos	Pos	+	+
HVAC system replacement (cars/trucks)				OK	+

Opportunities for TEs in Vehicles

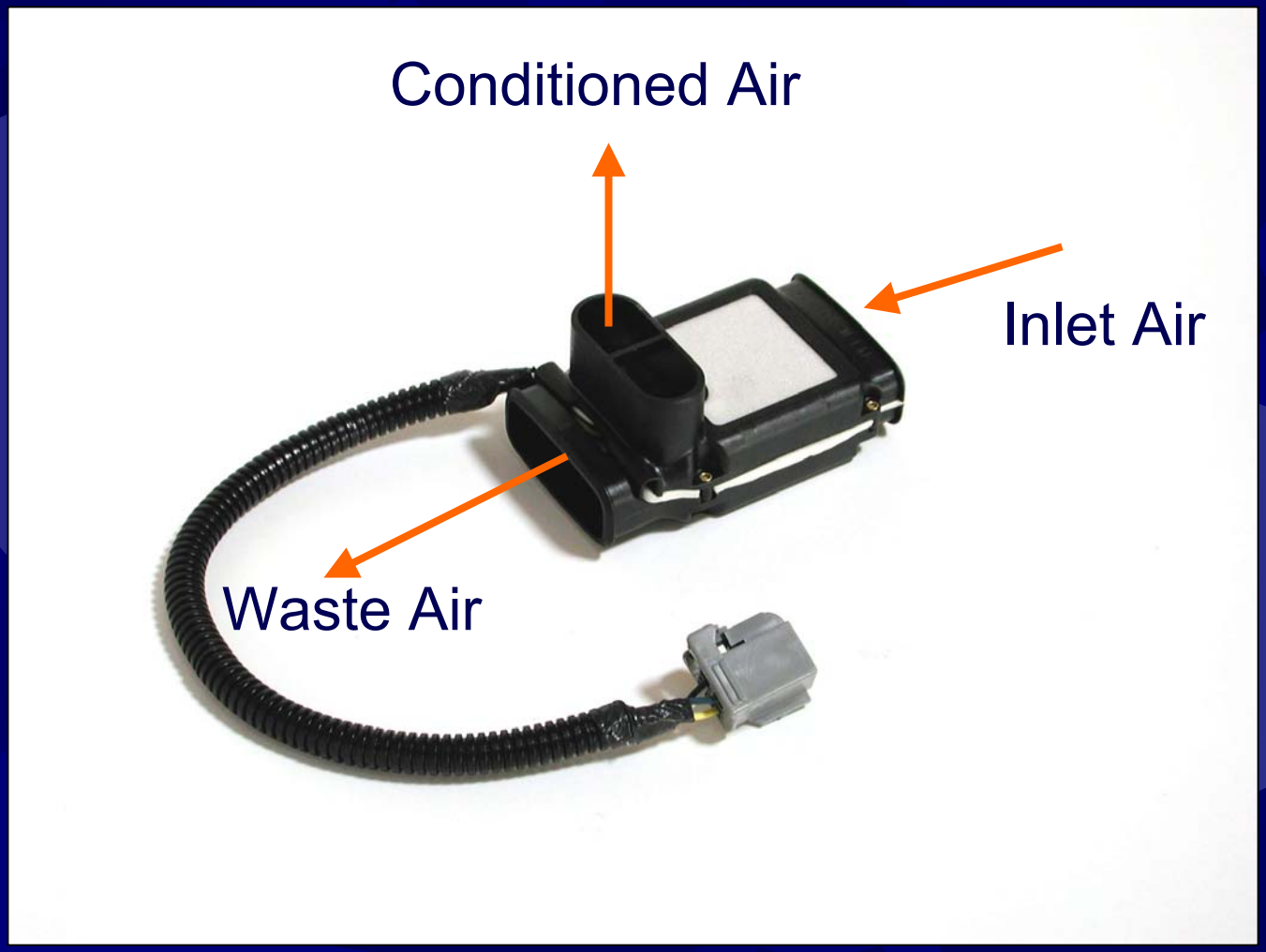
	Today	Today + BSST	Today + RTI	Today + RTI + BSST	ZT4 + BSST
Sensor/Controls					
Temperature/heat flux sensors	OK		+	+	+
Humidity sensors	OK		+	+	+
Electronic component cooling/control	Pos	OK	+	+	+
Power Generation					
Exhaust gas power recovery				OK	+
Radiator/engine heat power recovery				Pos	OK
Co-cycle generation				Pos	OK

CCS™ Vehicle Seat Application

Production CCS™ Assembly



Automotive CCS



Lincoln Navigator

75% take rate

Introduced Summer of 2000

4 TEs per vehicle

2001 Lexus LS 430

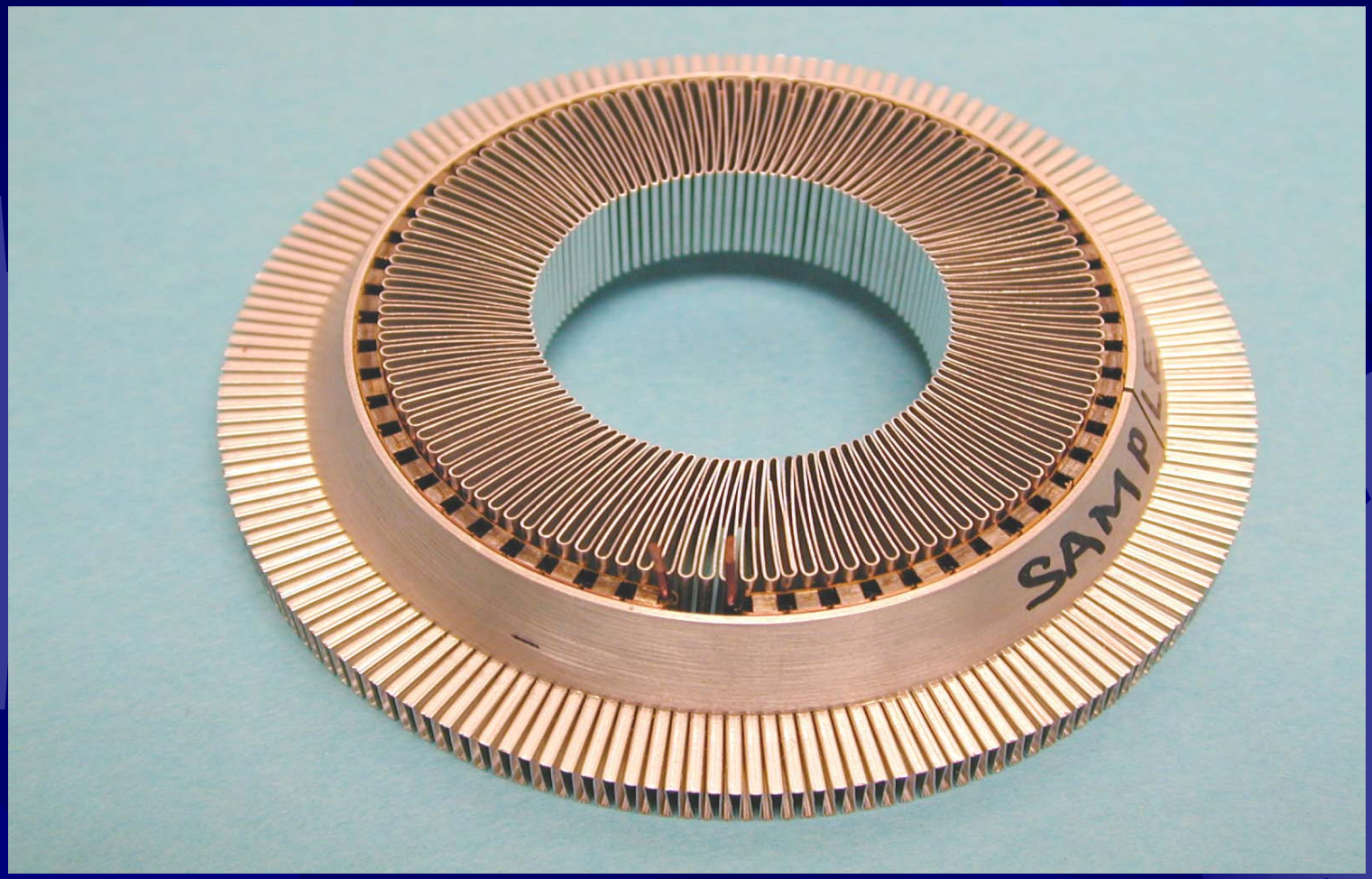
Front seat option in the all new Lexus flagship model
Available since October 2000
Sold in North America, Europe
75% to 80% take rate

Infiniti CCS for 2003

Q45 and M45

Front row seat option

Growth for CCS Programs



MTM Rotary Assembly

Summary

Performance over the last two years led four-fold increase in TEs

Enables new vehicular usage

Trends in the transportation industry favor conversion to electrical systems such as HVAC and personal comfort control

World-wide governmental regulations require further emission reductions and higher fuel efficiency

Solid-state cooling/heating/waste power generation offer simplicity, weight savings, reliability, and improved system functionality

Concluding Remarks

TEs have just come up on the radar screen.

Significant breakthrough in TE technology has come at a most opportune time to meet critical emerging needs of the vehicle manufacturing industries.

Just as electronics have replaced mechanical control sensing and display systems, there is now the prospect that solid-state TE systems will find favor over present mechanical cooling, heating and temperature control systems.