Robert Eller Associates LLC

CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES

THERMOPLASTIC ELASTOMERS: MEETING AUTOMOTIVE CHALLENGES

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TODAY'S OBJECTIVES

- The global automotive marketplace
- Current auto TPE example applications
- Identify the challenges
- How challenges met currently and potentially in the future with TPEs
- Future implications for TPE suppliers and the auto supply chain
- Examine the automotive TPE paradigm shift

THE AUTOMOTIVE TPE CHALLENGES

- Cost reduction
- Weight saving/help meet shifting emissions requirements
- Luxury experience without excessive cost adds
- Opening new applications
- Simplified parts fabrication
- Adhesion: the path to new TPE applications
- Controlling acoustics
- Controlling Foaming
- Globalization effects
  - implementing global TPE standards
  - implications of global platforms
  - regional supply chain shifts

IMPORTANCE OF AUTOMOTIVE VARIES BETWEEN TPEs

TPE TYPE	AUTO SHARE OF GLOBAL DEMAND	RECENT INCUMBENT	NOTE/ AUTO TARGETS
TPO	80%	None –TPO dominates	Bumper fascia, interior trim, skins
o-TPV	50%	NBR/PVC, ECO, CPE, EPDM	Boots/bellows, hose, short air ducts
SEBS	15%	EPDM, o-TPV	Auto share growing via soft touch, slush skins, seals
TPU	11%	EPDM, o-TPV	Grommets, sleeves, door sills, overmolded films, shift knobs, lamp seals, slush molding, wire/cable
COPE	10%	EPDM, o-TPV, fluorosilicones	Under-hood ducting, wire/cable, soft touch trim panels

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013

BODY/GLAZING SEAL CHALLENGES AUTO TPE BATTLEGROUND

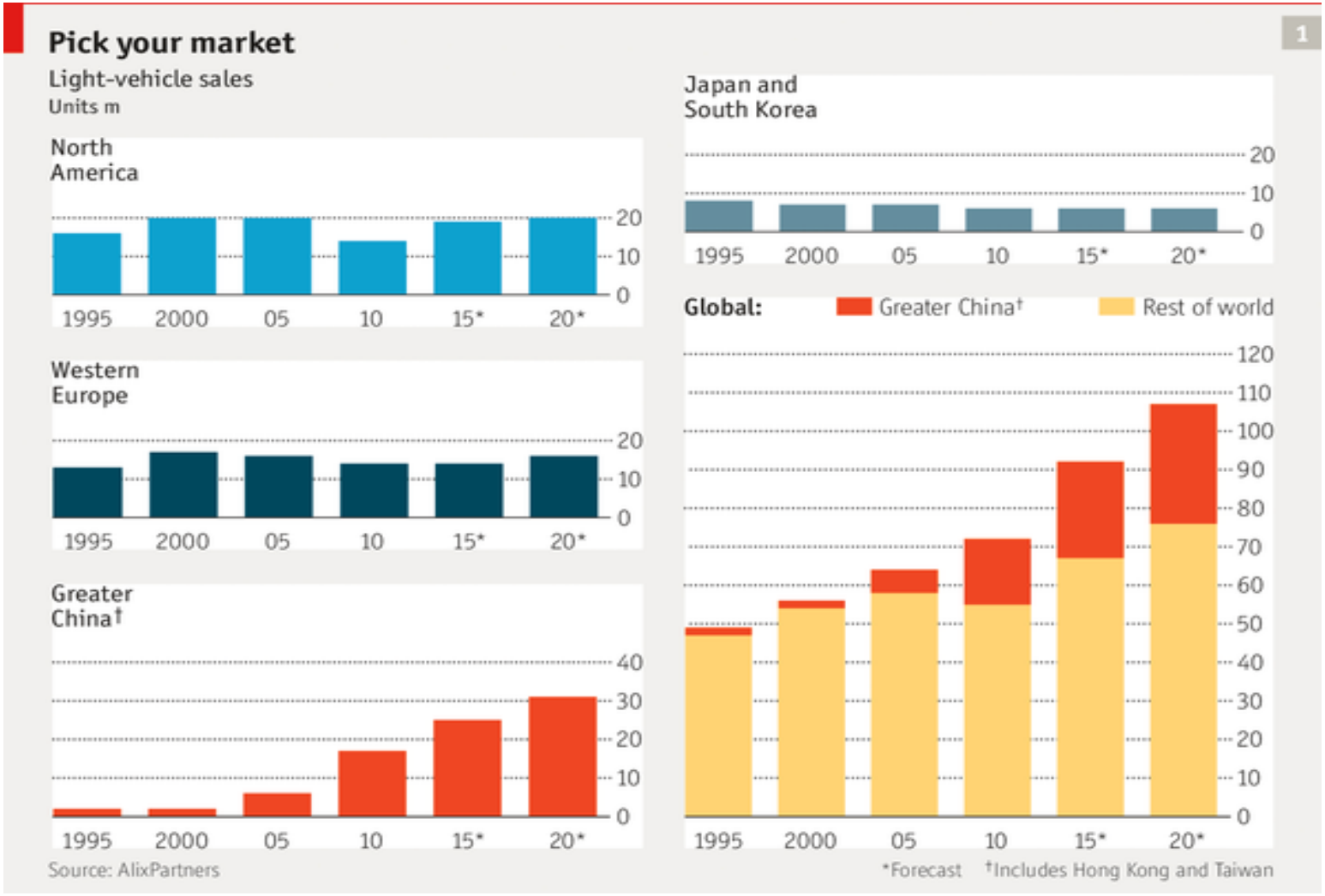
- **Dominant Incumbent:**
  - **EPDM**

- **TPE Challengers:**
  - **o-TPV, SEBS**

- **Dynamic vs. static requirements differ**
  - **Acoustic/wind noise performance (requirements increasing)**
  - **Adhesion (to glass, polycarbonate) emerging**
  - **Parts integration opportunities**
  - **Surface friction properties**
  - **Meeting regional performance differences**
  - **Overcoming institutional resistance**
  - **The small car challenge**

- **Large potential auto TPE market**

AUTO UNIT VOLUME GROWTH POTENTIAL IS IN CHINA AND INDIA



- **India pass car growth (2011-2020): 3 → 6-9 MM units**
- **India + China could represent growth potential ("11 – 20") of 20MM vehicles or 50kT at current SEBS and o-TPV compound utilization rates with no further penetration**

SOURCES: Alix Partners; Indian Auto Mfrs. Ass'n.; Robert Eller Associates LLC, 2013

N. AMERICAN SHIFT TO SMALLER SIZES→ AFFECTS TPE DEMAND

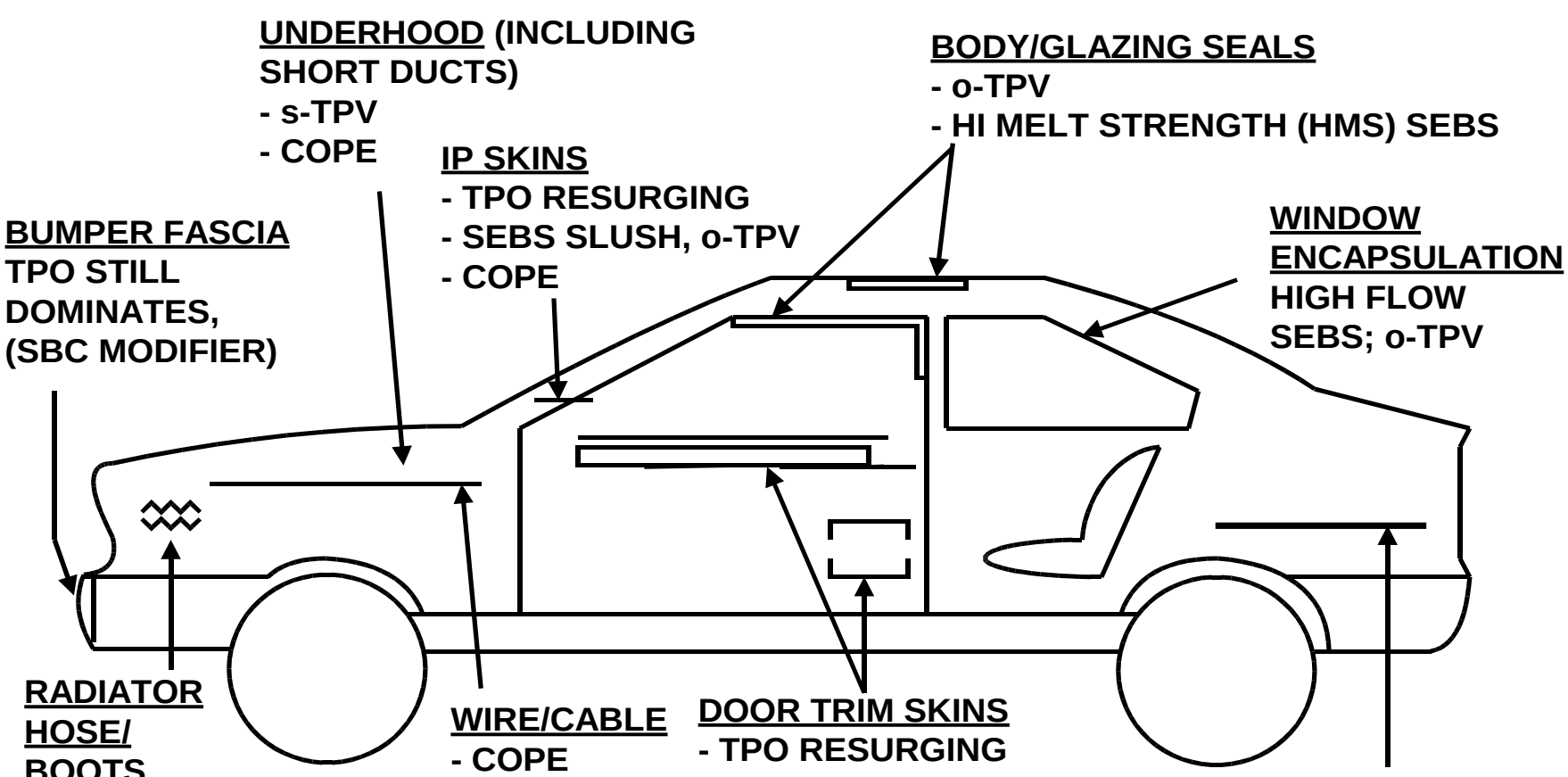
SEGMENT	SALES SHARE,%		GAIN/ LOSS,%
	2005	2014	
Compact utilities	6.0	13.4	7.4
Compact sedans	10.6	14.2	3.6
Mid-sized sedans	14.9	18.1	3.2
Wagons/Hatchback	5.3	7.5	2.2
Mid-sized utilities	15.2	12.4	-2.8
Mid-sized PUTs	4.2	1.3	-2.9
Full size PUTs	14.9	11.6	-3.3
Vans/Minivans	8.7	5.3	-3.4
Large sedans	8.2	4.1	-4.1
TOTAL SALES, MM UNITS	16.9	15.8	

Smaller vehicles share gain:
-smaller parts sizes
-increased pressure for soft interior features
-increased under-hood temperatures

DATA SOURCE: AUTO PACIFIC

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013

AUTOMOTIVE: KEY TARGET MARKET FOR NEW TPEs



THE AUTO TPE MARKET

- GLOBAL FOOTPRINT REQ'D,RECENT LUXURY DRIVE
- KEY DRIVERS: LOW VOC/ODOR, OIL FUEL RESISTANCE, HEAT RESISTANCE, SUSTAINABILITY (BIO), WEIGHT SAVE/LUXURY LOOK/HAPTIC, SMART SURFACES

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013

r/mydox/visio/auto key tgt for new tpes 2013.vsd

TPE CHALLENGE: GLOBALIZATION

The challenges, how to:

- **Implement global specifications (starting)**
- **Have a uniform global TPE supply and fabrication footprint**
- **Retain value associated with global standards**
- **Avoid commoditization and price challengers from local TPE suppliers**

Background:

- **Global platform usage is increasing**
  - **VWs MQB platform (5.5 MM global vehicles/yr) is leader**
  - **Platform volume for other OEMs (Toyota, Ford, Hyundai, GM is 2-3 MM vehicles/yr)**
  - **Typically on B/C segment vehicles**
  - **Creates opportunities for TPE suppliers with global footprint (a "must have")**

- **TPEs offer greater product uniformity between regions for TPEs vs thermoset rubbers**
  - **OEMs prefer uniform products /grades from -the -bag rather than in-house compounded rubbers**

TPE supplier solutions:

- **Meet global specs (not always easy)/local pressures**
- **Assure lot-to-lot uniformity. Build an unassailable reputation**
- **Follow OEM regional shifts**
- **Assure global footprint**

TPE CHALLENGE: WEIGHT SAVING

The challenges: save weight while adding value. Help meet steeply increased emissions requirements

Background:

- **A key target with new fuel economy regulations**
- **TPEs generally have a density advantage vs. incumbents**
- **Weight savings via parts consolidation are possible (especially where fastening devices can be eliminated)**

TPE solutions:

- **Target metal substitution**
- **Look for hard/soft combinations**
- **Foaming**
- **Thin wall where possible**
- **Solve the adhesion problems**
- **Seek multi-functionality (e.g. EMI shielding TPE gaskets)**

TPE CHALLENGE: COST SAVING

The challenge:

- Reduce total parts cost

Background:

- TPEs generally cost more than incumbent
- OEMs working to examine total costs
- OEM demanding high performance, form and function, perceived quality
- Avoiding “cheap plastics” look

TPE solutions:

- Parts consolidation
- Redesign for ease of assembly
- Labor cost reduction
- Design for disassembly and recycling

TPE CHALLENGE: ADHESION

The challenge:

- **Improved adhesion is an application enabler**
- **Value add potential**

Background:

- **Application in coatings, multi-materials , construction, blends, fillers, reinforcements, surface decorations**
- **Logos**

TPE solutions:

- **Sprayed surface adhesion promoters**
- **Additives and compounds**
- **Usually polar/non-polar combinations**
  - **-- MA/resin combinations**
  - **-- SMA**

TPE CHALLENGE: CASCADE EFFECT

The challenge:

- Incumbents can be replaced

Background:

- Many early entry TPEs over engineered
- Incumbents with brand recognition are vulnerable
- New suppliers in Asia challenge western TPE incumbents
- Warranty concerns
- BRIC quality/price tiers may differ than those of global incumbent TPE suppliers

TPE Solutions:

- Provide equal or greater properties vs. incumbent TPEs

THERMOPLASTIC ELASTOMERS IN WINDOW ENCAPSULATION

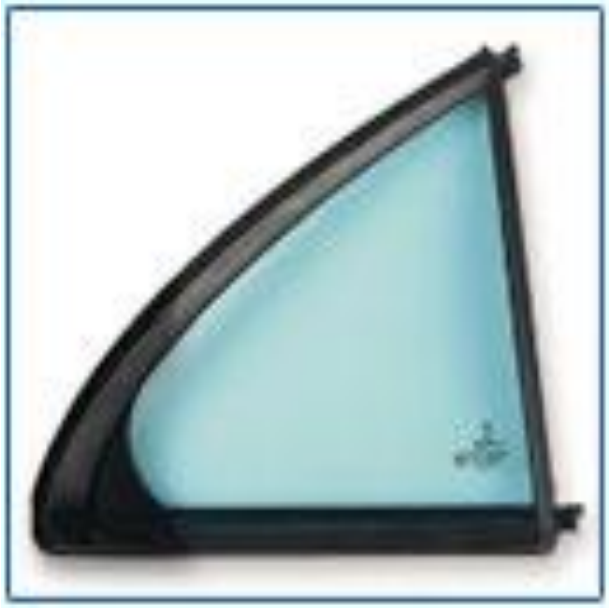


Photo source: Kraiburg

- **Application:** Rear quarter window encapsulation seal
- **TPE Candidates:** PUR, o-TPV, SEBS (H-SBC), PVC, EPDM
- **Key Properties:** High flow (to reduce breakage)
  Glass adhesion
  UV/weather resistance
  Low compression set
  Squeak resistance
  Scratch resistance

Photo source: Robert Eller Associates LLC

- **Notes: Example of intense inter-material competition**
  - Example of static seal application
  - Two shot adds value
  - Colors?
  - Narrower profiles?
  - Systems cost save opportunities
  - Polycarbonate glazing could shift requirements

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013

SHORT AIR DUCTS: MODERATE TEMPERATURE UNDERHOOD APPLICATION

Photo source: ExxonMobil

- Application: Short clean air duct
- TPE Candidates: o-TPV, PVC/NBR
- Rubber competition: EPDM
- Key Properties:
  - -Constant temp resistance to 135^{0}C
  - -Oil resistance
  - - 75A hardness
- Fabrication process: Injection or blow mold
- Notes:
  - -Recent example(not shown) is Hyundai short air duct based on Santoprene ™ TPV
  - -s-TPVs and COPE for higher temp ducts
  - - Weight and cost save vs TS rubbers
  - - Recyclability a benefit of TPE use

TECHNICAL TRENDS: SEBS COMPOUNDS

- Improved SEBS grades
  - Slush moldable
  - Coated fabric grades
  - Able to compete with o-TPV in some applications

- Competition from improved PVC grades to answer SEBS challenge

- Bio-elastomers

- Continued growth of multi-component technology
  - Overmolding/2-shot and extension to foaming methods
  - Co-blow molding
  - Profiles

- Evolution of soft touch: silky feel

- Chinese commodity resin suppliers catching up in quality and versatility, not there yet

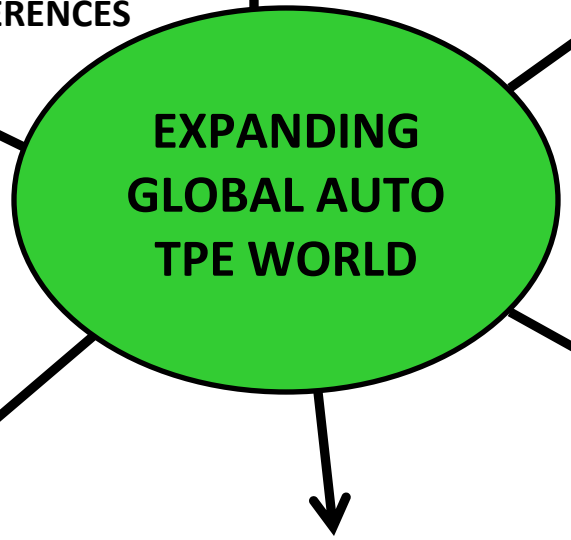
TECHNICAL TRENDS AFFECTING AUTOMOTIVE TPEs

- **COPEs:**
  - **High temperature resistance**
  - **Adhesion**
  - **Haptics**
  - **Multi-shot**

- **TPOs:**
  - **High flow**
  - **Thin wall capabilities**
  - **Use in acoustic components**
  - **Role of POEs**
  - **Renewed skins growth**

- **o-TPVs:**
  - **High flow/glass adhesion grades for window encapsulation**
  - **Continued penetration into body seals and glass run channels**
  - **Improved attachment systems for body seals**

GLOBAL AUTO TPE STRATEGY ANALYSIS WHEEL



REGIONAL AUTO PRODUCTION SHIFTS IMPLICATIONS
- ASIA, N. AMERICA , S. AMERICA
- EMERGING MARKET ADAPTATION
- INDUSTRY STRUCTURE DIFFERENCES
- QUALITY/PRICE TIER DIFFERENCES

GLOBALIZATION
- GLOBAL PLATFORM IMPLICATIONS
- REGIONAL SUPPLY CHAIN DIFFERENCES
- TIER 1 CONSOLIDATION

SUBSTITUTION
- CASCADE EFFECT → LOWER COST TPEs
- BIO-TPEs
- RUBBERS
- SUSTAINABILITY, BIO-TPEs ROLE

PROCESS INNOVATIONS
- FOAMING APPROACHES
- MULTI-SHOT MOLDING/CORE BACK
- SLUSH MOLDING
- TEXTILE COATING
- DYNAMIC MOLD HEATING

BROADER PROPERTY RANGE
- SOFT TOUCH
- IMPROVED ADHESION
- HIGHER TEMP CAPABILITY
- SURFACE QUALITY

NEW APPLICATIONS DRIVERS
- GROWTH VIA BOTH AUTO PROD'N AND SUBSTITUTION
- LUXURY (SOFT TOUCH APPROACHES)
- WEIGHT SAVE
- FABRICATION ASSEMBLY/ MATERIALS COSTS SAVE
- RIDING ETP SUBSTITUTION'S COATTAILS
- FOLLOWING ELECTRONICS GROWTH

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013

THE PARADIGM HAS SHIFTED IN GLOBAL AUTOMOTIVE TPEs

- Grade commoditization→ bifurcation into commodity & specialty

- Emerging auto markets:
  - Highest global growth rates

- Auto TPE demand via both unit volume growth and substitution

- Auto TPE supply chain broadening, new entrants

- Emergence of Asian TPE competition

- Emergence of global auto platforms

- Emergence of global TPE standards (starting with TPOs)

- Opportunities created by TPEs well suited to new challenges:
  - High temperature
  - Luxury feel
  - Lightweighting/parts integration

SUMMARY

- Most of the TPE challenges are easily met via the inherent capability of TPEs
- Globalization will help TPE penetration into automotive
- Auto TPE property envelope is expanding enabling access to new targets:
  - Heat resistance
  - Soft touch
  - Foaming
  - bio-TPEs

- Fabrication methods → offer process cost save
  - Two shot
  - Core-back methods
  - Co-processing (co-blow, coex)

- Global platform trend offers global TPE opportunities

- Regional auto TPE growth
  - Emerging markets (increased substitution to Western levels, organic growth)
  - Western, global TPE brands will benefit most in short term
  - Slowing of European markets

SUMMARY (CONT'D.)

- **"Windows" to TPE Growth:**
  - **Adhesion**
  - **Foaming**
  - **Parts consolidation**
  - **High temperature resistance**
  - **High flow**
  - **Soft touch**
  - **Surface quality**
  - **Interior lighting**