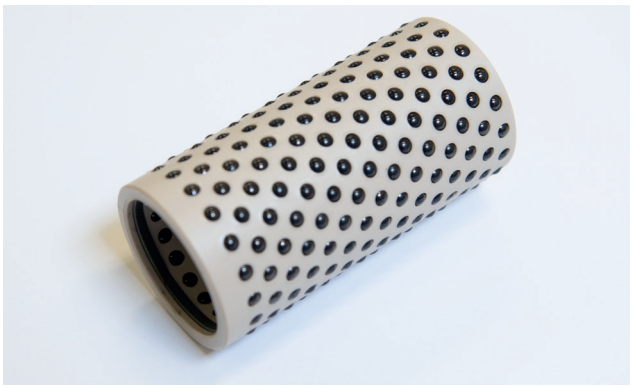
Hybrid cages

Initial situation: Applications whose requirements cannot be met with standard material combinations



Possible materials

Cage	**Rolling element**
Aluminum	Steel 1.3505
Brass	
PEEK	Ceramic Al203
POM	
INOX (e.g. 1.4307)	Stainless steel 1.4125

Possible requirements

- Without lubricant
- Ultrasound resistant
- Non-magnetic
- High-temperature resistant
- Weight reduction
- Acid resistant
- Suitable for space travel
- etc.

Served application industries

- Ultra-high vacuum environment (rare XHV (<10^{-12} bar))
- Scientific applications and research
- Biopharmaceuticals (process optimization, purity requirements)
- GIM Glass Injection Molding, glass lens manufacturing
- High or low temperature
- Magnetic field applications, electrically sensitive applications

Material description

Material of balls	Advantages	Disadvantages
Stainless steel 1.4112	Inexpensive, similar to 100Cr6	Not completely stainless steel, hardenability less than 100Cr6
Ceramic (see bellow)	Can be used for practically anything, depending on the selected ceramic	Very expensive
Roller bearing steel	Ideal for roller bearings, inexpensive	

Material of cage	Advantages	Disadvantages
Aluminum	Easily available, low cost, lightweight, universally applicable	Mechanically and thermally resistant, tends to be sticky (abrasion and deposit)
Brass	Wide range of applications, partially self-lubricating, ultrasonic cleaning	
PEEK	Up to >400°C, lightweight, FDA compliant, cleanroom, no abrasion	Expensive
POM	Up to 80°C, very affordable, lightweight, FDA, cleanroom, no abrasion	Mechanical values
INOX	Widely available, broadly applicable >700°C	Weight, price

Expenses

Costs should always be considered as TCO. Looking purely at the item price between a steel cage with ceramic balls and a standard brass cage results in a cost factor of 7-15, but with TCO the differences are significantly smaller, possibly even to the advantage of the more expensive product.

TCO

Total Cost of Ownership includes all costs from procurement to completion of the project.

Types of ceramics

Si3N4 Silicon nitride Gray / Black 800°C, 75 ~ 80 HRC	Lightweight, smooth running, high strength, low wear, electrically insulating, excellent resistance to temperature fluctuations, suitable for dry running, low coefficient of friction, corrosion and pitting resistance, very high chemical resistance. **Applications:** Military, aerospace.
Al203 Aluminum oxide Whitish, yellowish Up to 1500°C	Good mechanical properties, corrosion-resistant, abrasion-resistant, heat-resistant, self-lubricating (for dry running). Electrically insulating, color may vary. Extremely smooth running properties, low coefficient of friction, corrosion and pitting resistance, very high chemical resistance. **Applications:** Special applications in corrosive environments.
SiC Silicon carbide Black	Good mechanical properties and rigidity, good corrosion and wear resistance. Electrically conductive. Also suitable for high-temperature applications.
ZrO2 Zirconium oxide Whitish -196°C to 400°C, 70 HRC	Fireproof, very high corrosion, abrasion, and heat resistance. Impact increases toughness. Extremely smooth running properties, ideal for dry running, low coefficient of friction, corrosion and pitting resistance, very high chemical resistance. **Applications:** Special applications in corrosive environments, grinding mills.