Technical Ceramics

SiC- and B_4C-based hard ballistic components

Superior light-weight solutions for maximum protection

schunk-technical-ceramics.com

Schunk – A worldwide success.
Always at your side.

Schunk is the world leader in the development, production, and application of carbon, ceramic, quartz and sinter metals solutions. Like no other, Schunk combines innovation and technological know-how with exceptional service orientation to create a range of services that is unique in the market.

Schunk is a partner who offers you all the technological possibilities of a globally operating company and pragmatically puts your ideas into practice. And always precisely tailored to meet your requirements – for industrial volume markets as well as for highly specialized niche markets. Our technology portfolio, including mechanical carbon, electrical carbon, high temperature applications and technical ceramics, offers you perfect solutions for a diversity of industrial applications.

Empowering, idea-driven, collaborative – this is how the Schunk Group has made a name for itself as a globally-active technology group since 1913. Empowering, because we build bridges for our customers to help them develop better products and conquer new markets with innovative technologies. Idea-driven, because innovations are a significant aspect of our company culture. Collaborative, because every employee of the Schunk Group is focused on the customer.

The Schunk Group
The Schunk Group is a globally operating technology company. The company is a leading supplier of products made of high-tech materials – such as carbon, technical ceramics and sintered metal – as well as machines and systems – from environmental simulation and air conditioning to ultrasonic welding and optical machines. The Schunk Group has around 9,000 employees in 29 countries and achieved sales of €1.3 billion in 2021.

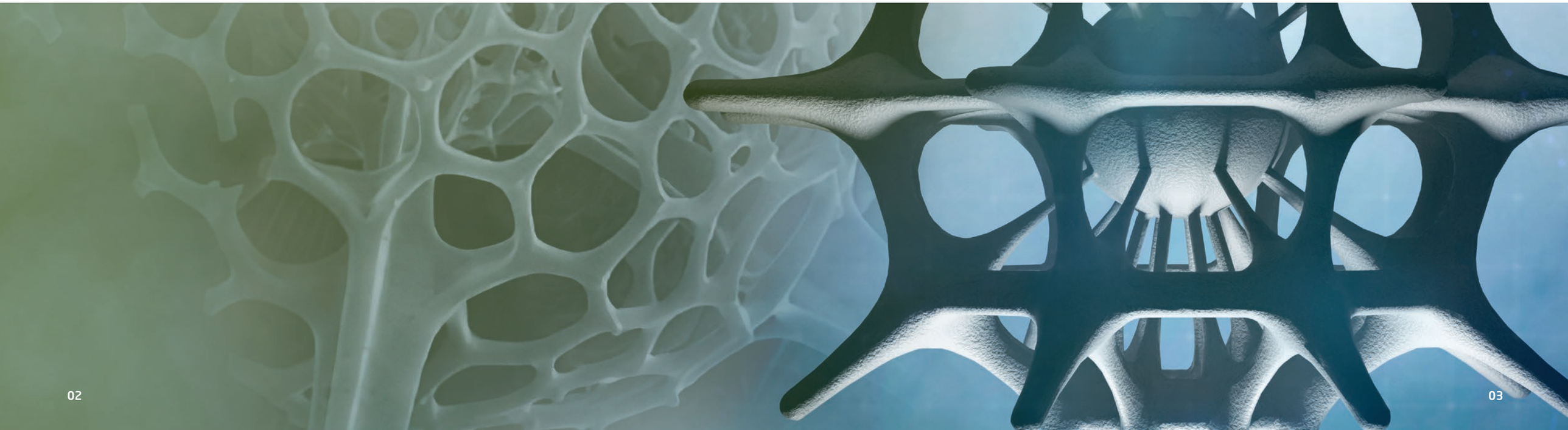
Perfect structures
Inspired by nature – Made by Schunk

Evolution in nature has inspired structures of divine proportions with optimized strength, weight, and visual appeal. Schunk innovations allow for these structures to be implemented in modern, technical products like sinter-metal and engineered ceramics. As a technological leader in engineered materials and processes for a variety of markets and applications, we can help you develop solutions, to advance your position in the marketplace.

Are you looking for true innovation?

When it comes to the challenges of tomorrow, it is not enough to improve today's products, groundbreaking innovation is needed. These breakthroughs are achieve by those who push boundaries and take that extra step toward possibilities. We at Schunk continue to take that extra step to explore and find the needed answers to tomorrow's questions

Schunk is prepared to be your product development partner.
Bring us your technical challenge.



Success by innovation – Technical Ceramics for maximum protection

Schunk Ingenieurkeramik GmbH has been a technical pioneer and market-leading manufacturer of technical ceramics for more than 30 years .

The company provides a wide product portfolio consisting of RBSiC (silicon-infiltrated, reaction-bonded silicon carbide), the innovative hybrid-material RBB$_4$C (reaction-bonded boron carbide) as well as NSiC (silicon nitride-bonded silicon carbide) to defeat a variety of threats. Schunk brings it innovative mindset to supporting defense and specifically ballistic armor. Schunk was the first to implement a state-of-the-art manufacturing process for pressure-cast RBSiC and RBB$_4$C resulting in highly-efficient, high volume production while increasing quality and consistency. More recently, Schunk pushed technological boundaries with the introduction of full-scale production of 3D printed grade of SiC we call IntrinSiC®.

A focus on process technology and efficiency has allowed us to achieve consistent high quality while also optimizing weight, protection level, and cost in our product line SafeGuard. This is reflected by our products being used by more than 20 NATO and allied countries for both military and law enforcement. Our state-of-the art manufacturing processes are the cornerstone for the best price/performance ratio for our advanced ceramics and has enabled us to become Europe's leading manufacturer of high-quality body armor ceramic.

Schunk provide technical ceramics with superior light weight structures and outstanding ballistic performance with the following benefits to our customers:

- Best price-performance ratio for advanced ceramics
- Up to 30 % weight advantage vs. Alumina
- State-of-the art manufacturing technologies as being worldwide first-mover and technology leader with 3D printed and pressure casted RBSiC and RBB$_4$C
- Consistently high quality standards by controlled homogeneous and uniform microstructures combined with tight dimensional tolerances
- Unique outstanding degree in design flexibility due to worldwide class-leading 3D printed grades
- Experience from over 1 million sold body armor ceramic plates worldwide
- Ceramic solutions for all common threats such as NIJ4, ESAPI, SK4, STANAG 1-6 etc.

In the past, shapes were defined by manufacturing processes – Today, only your imagination matters.

IntrinSiC® introduces innovation for the production of large and complex monolithic components of silicon-infiltrated, reaction-bonded silicon carbide (RBSiC). The new process makes it possible for the first time to efficiently manufacture large and complex components with diamond-like hardness using a 3D printing process.

Schunk is pleased to announce the next step in innovation – IntrinSiC® B$_4$C (RBB$_4$C) for maximum ballistic protection.

From prototype to volume production
The IntrinSiC®-product line combines excellent material properties of RBSiC and RBB$_4$C with the advantages of 3D printing. 3D printing allows for a new level of design potential not otherwise capable to achieve with standard ceramic forming processes. Even large and complex monolithic structures with undercuts and cavities are feasible in a single forming process. Near-net-shape via additive manufacturing reduces wasted material and offers a solution with minimum weight and maximum protection even for complex protection requirements such as for helicopters and aircraft.

IntrinSiC® combines the following process and material advantages:

Process advantages of 3D printing

- Near-netshape protection ceramics to minimize weight
- Realizing of undercuts and/or cavities
- No time-consuming manufacturing from patterns and moulds (CAD-data means parts ready for manufacturing immediately)
- High degree of process-flexibility
- Fast production lead times
- Design modification by the click of a mouse
- No time-consuming retooling of moulds
- Digitizing from existing parts by reverse engineering

Material advantages of RBSiC

- Low mass
- Superior hardness for advanced threats

Material advantages of RBB$_4$C

- Ultra light weight
- Outstanding hardness for extreme energy dissipation

Where maximum safety is the standard

Whether ceramic armor plates for aviation, ground vehicles, or personal protection – as a long-term supplier to these industries, we know what matters.

For high protection levels, high-performance ceramics are needed to defeat these special threats.
Schunk ceramic are able to defeat these threats.

Body armor

Technical advanced ceramics for military, police and security services. Monolithic ceramic plates for protective vests with low weight and high protective performance in a wide range of shapes, sizes, curvatures and wall thicknesses according to common standards.
In addition, we also enable special geometries such as “Female Plates”, which are specially shaped protective plates that take special account of the female anatomy of those wearing protective vests.

Aircraft armor

Technical advanced ceramics for aircraft and helicopters with particularly lightweight structures and outstanding ballistic protection performance. Customized lightweight structures with our world-leading 3D printed manufacturing technologies IntrinSiC® (RBSiC) and IntrinSiC® B_4C (RBB_4C).

Vehicle armor

Advanced technical ceramics for panel components used to reinforce land vehicles (e. g. for armored military vehicles as well as for specially protected police vehicles). Customized lightweight structures with our world-leading 3D printed manufacturing technologies IntrinSiC® (RBSiC) and IntrinSiC® B_4C (RBB_4C).

Material overview and fields of application

SafeGuard GD

Our SafeGuard GD is the class-leading pressure-cast RBSiC (silicon-infiltrated, reaction-bonded silicon carbide) with a density of 3.1 g/cm³ and proven performance in the market over several decades. SafeGuard GD fulfills the requirements for protection against most threat scenarios. SafeGuard GD is chosen by our customers not only for use in specific military programs, but also as a cost-effective hard-ballistic component in protection systems when budget criteria play a decisive role in civilian tenders from police forces and law enforcement agencies.

IntrinSiC®

IntrinSiC® is our class leading 3D printed RBSiC (silicon-infiltrated, reaction-bonded silicon carbide) with a density of 3.05 g/cm³. This material is substantially similar to SafeGuard GD for mechanical properties with a slightly different chemistry due to it being 3D printed. Ballistically, it performs very close to SafeGuard GD with some exceptions for specific threats. 3D printing of this material allows it to be made in custom, complex, large, and strongly curved shapes.

SafeGuard NG

Our SafeGuard NG is a superior NSiC (silicon nitride-bonded silicon carbide) with a density of 2.85 g/cm³ offering good cost-/performance ratio for specific threats. This specific grade is available in slip-casting technology only. Depending on the specific threat, the ballistic retention performance can be adjusted by increasing the wall thickness.

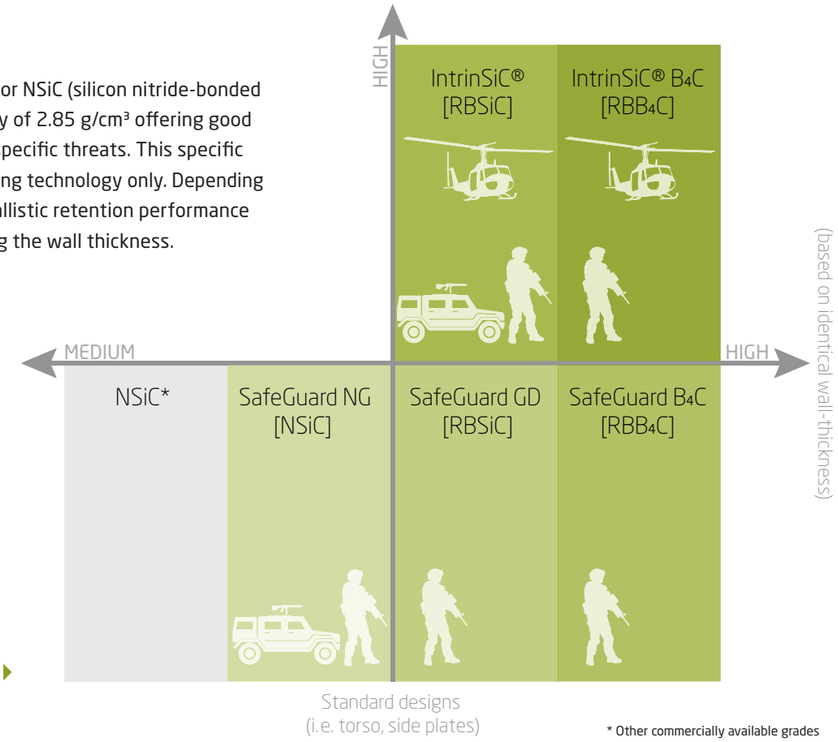
SafeGuard B_4C

Our SafeGuard B_4C is the class-leading pressure-casted RBB_4C (reaction-bonded boron carbide) with a density of 2.85 g/cm³ and the preferred standard grade for the vast majority of military suppliers. The Max-Lightweight Structure defeats most small arms threats and provides outstanding hardness for extreme energy dissipation.

IntrinSiC® B_4C

IntrinSiC® B_4C is our class leading 3D printed RBB_4C (reaction-bonded boron carbide) with a density of 2.88 g/cm³. This material is substantially similar to SafeGuard B_4C for mechanical properties with a slightly different chemistry due to it being 3D printed. Ballistically, it performs very close to SafeGuard B_4C with some exceptions for specific threats. 3D printing of this material allows it to be made in custom, complex, large, and strongly curved shapes.

Ranking of ceramic grades in correlation of ballistic performance Indicator vs. degree of complexity



* Other commercially available grades

Body armor

High hardness threats require high hardness ceramic strike faces on the body armor laminate to crack and erode the threat thus distribute the momentum so that the fragments can be caught by the composite behind the ceramic.

The combination of high hardness and low density of the ceramic armor plate our product for lightweight solutions with high protection performance.
Thanks to our leading production technology, we are able to flexibly supply both prototype samples and large series-production quantities in reproducibly high quality and on time.

Monolithic plates for ceramic body armor

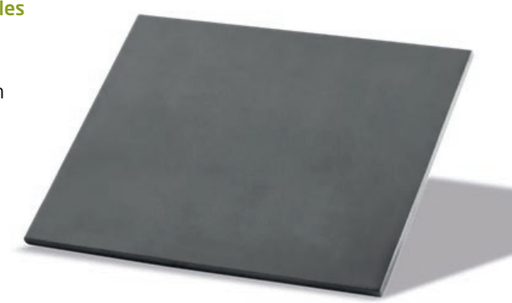
You benefit from these advantages:

- Lower weight than conventionally used hard armor materials (e.g. Alumina ceramics, armor steel plates)
- High hardness
- Protects against armor-piercing bullets, with multi-hit capability
- SafeGuard GD material: Reaction-bonded silicon carbide with a low metallic silicon and favorable cost-effectiveness, density 3.05 g/cm³
- SafeGuard B_4C material: Reaction-bonded boron carbide with a high hardness and high performance, density 2.85 g/cm³
- Proven protection against NIJ4, ESAPI and SK4 with suitable backing

Aircraft Armor

Aircraft armor can require large, complex-shaped monolithic ceramic components. Reduction of seams and reduced assembly time enables cost-effective solutions with optimized weight.

Our modern production technology including various forming processes, green machining, and precision finish grinding allows us to manufacture a variety of geometries with precise cuts, cut-outs, holes, and other features.



Monolithic ceramic plates for vehicle protection

Helicopter seat made of IntrinSiC® B_4C

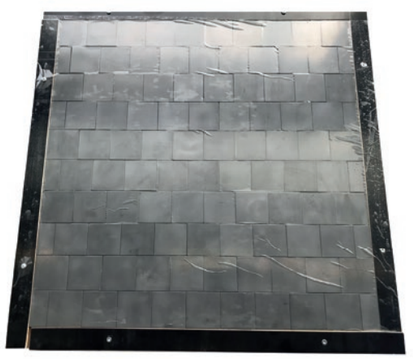
You benefit from these advantages:

- Lower weight than conventionally used hard armor materials (e.g. Alumina ceramics, armor steel plates)
- High hardness
- Protects against armor-piercing bullets, with multi-hit capability SafeGuard GD material: Reaction-bonded silicon carbide with a low metallic silicon and favorable cost-effectiveness
- SafeGuard B_4C and IntrinSiC® B_4C (3D printed) material: Reaction-bonded boron carbide with a high hardness and high performance
- Proven performance against STANAG level 1-5 when using a suitable backing

Vehicle armor

Dimensionally precise cladding of large, complex surfaces for vehicle protection is only possible through the efficient use of polygonal ceramic armor components. In addition, the mosaic-like structure optimizes the ability to defeat multiple armor-piercing projectiles.

The combination of high hardness and low density of the plates of Schunk ceramic allows for lightweight solutions with high protection performance. Thanks to our leading production technology, we are able to flexibly supply both prototype samples and serial production quantities with consistent high quality and on time.



Polygonal ceramic plates for vehicle armor

Grade		SafeGuard GD	SafeGuard B_4C	SafeGuard NG	SafeGuard NT	IntrinSiC®	IntrinSiC® B_4C
Nomenclature		RBSiC	RBB_4C	NSiC	RBSiC	RBSiC	RBB_4C
Density	[g/cm³]	3.10	2.85	2.85	3.09	3.05	2.88
Young's Modulus	[GPa]	360	350	220	360	380	270
Flexural Strength 4point bending	[MPa]	280	220	200	280	210	160
Hardness HV0.1	[MPa]	25,000	29,000	25,000	25,000	25,000	29,000
Weibull Modulus		~10	~10	-	~10	~14	-
Chemistry	[wt.-%]						
SiC		87	57	65	88	86	60
Si (free)		12	12	-	12	14	20
B_4C		-	30	-	-	-	20
Si_3N_4/Si_2ON_2		-	-	27	-	-	-
Oxides		-	-	balance	-	-	-

You benefit from these advantages:

- Lower weight than metallic materials
- High degree of hardness
- Protects against armor-piercing bullets, even with multiple hits
- Increased multi-hit capability thanks to mosaic-like structure
- IntrinSiC® B_4C material: Reaction-bonded boron carbide with a higher degree of hardness and excellent protection performance
- SafeGuard NG material: Reaction-bonded, silicon-infiltrated silicon carbide with favorable cost-effectiveness
- Delivers protection against STANAG 2-6 combined with appropriate backing

Special Service

In addition to Schunk's business unit Technical Ceramics, the Schunk Group – a globally operating technology company – offers a broad spectrum of technical solutions from different business units supporting defense application such as HVAC/environmental testing and Carbon Fiber Reinforced Components.

Want to learn more about this topic? Get in touch with us!

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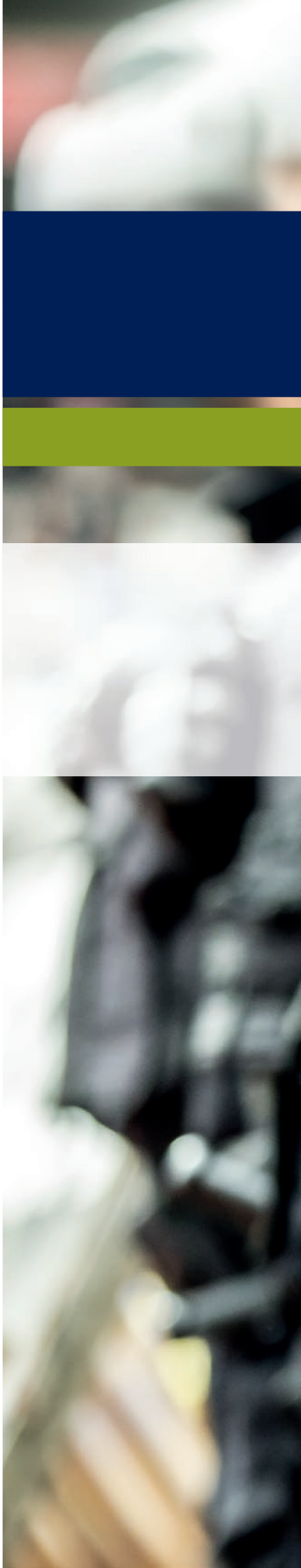

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