OCSiAl

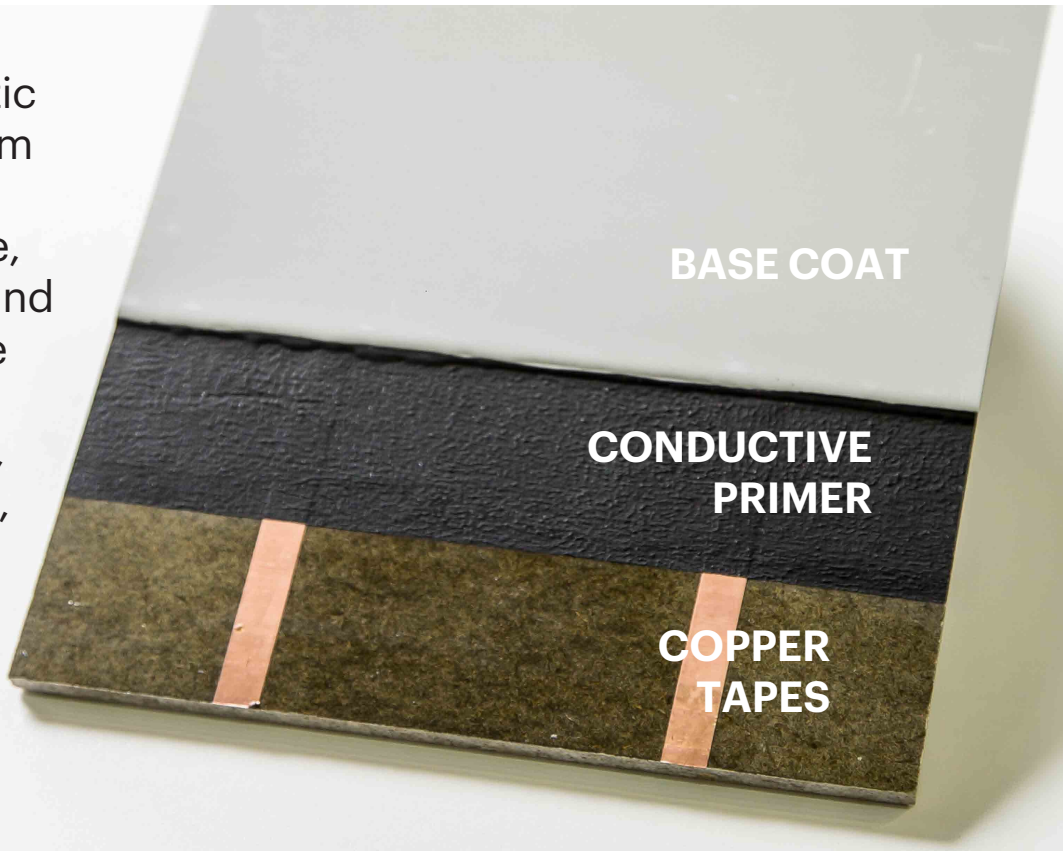
graphene
nanotubes
for the global
industry

3 REASONS TO START USING TUBALL™ NANOTUBES FOR ANTI–STATIC FLOORS

Presented by
Vladimir Kravchenko,
OCSiAl Development and Support Leader,
Thermosets

Depending on the regulation document and procedure there are two common requirements for making such floors anti-static: surface-to-surface or surface-to-ground resistance. Below is the example of a floor with surface-to-ground resistance for dissipative and conductive ranges according to ASTM F150.

The structure of static dissipative floor, from bottom to top, is as follows: copper tape, conductive primer and a base coat. In some specific cases, an additional thin layer, known as a top coat, can be applied.

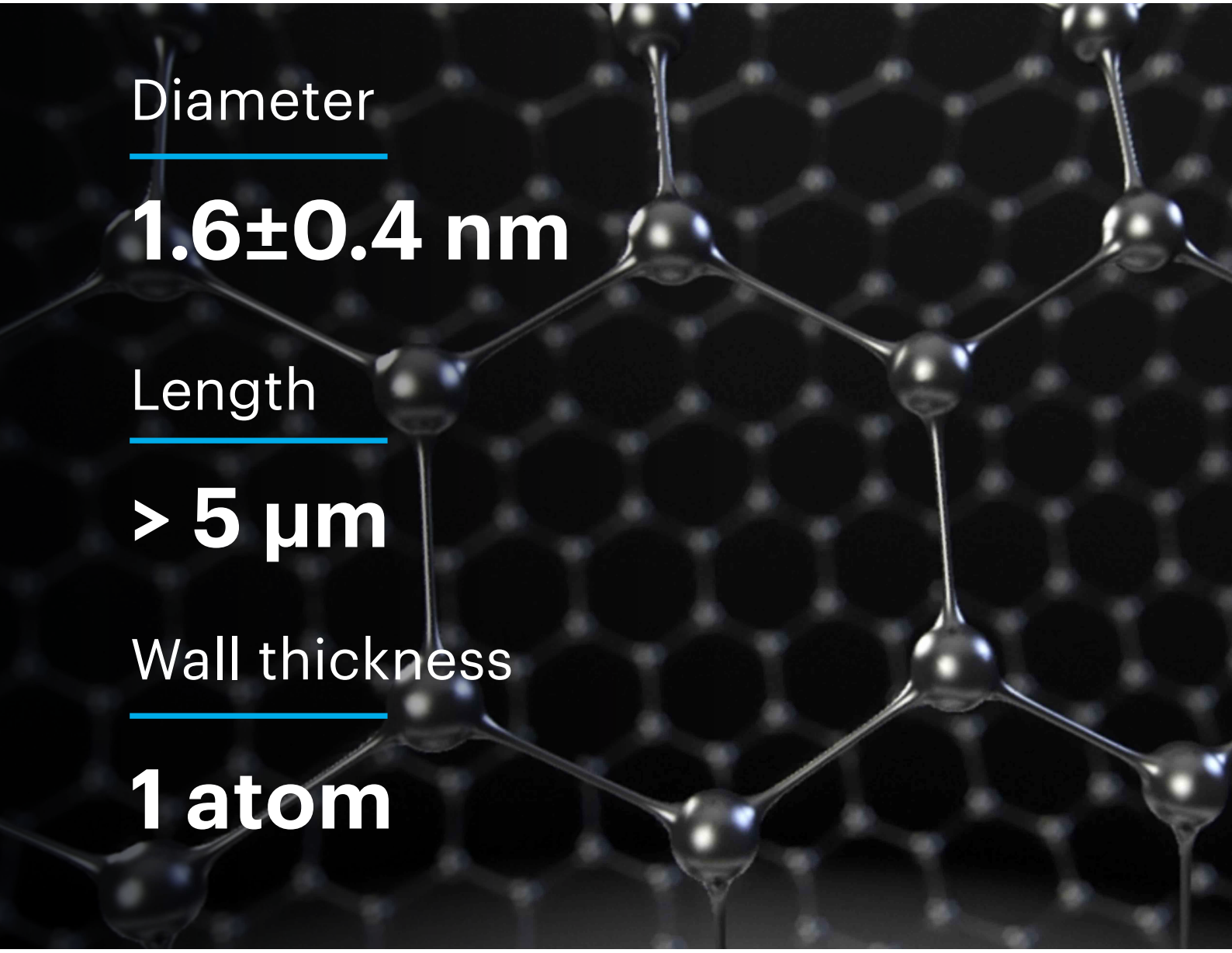


HOW ANTI-STATIC FLOORS WORK
Generated electrical charges should pass from the surface to ground

REQUIREMENTS EXAMPLE
Surface-to-ground resistance:
- dissipative range: 10^6–10^9 Ω
- conductive range: 10^6–2.5×10^4 Ω

To meet such strict regulations, the compound of the flooring base coat should be conductive. The use of anti-static or conductive additives is the most common solution in the flooring industry.

What are TUBALL™ graphene nanotubes?



These are referred to as single wall carbon nanotubes or graphene nanotubes. Each one is a tube with a wall the thickness of a single atom of carbon, a diameter of about 1.6 nm, and a length of about 5 microns. And it can be used as a conductive agent to provide electrical conductivity to different polymer matrixes.

What are the driving forces for ESD floor compounders and installers to use TUBALL™ nanotubes?

1 reason

TUBALL™ NANOTUBES MEET COMPLEX FLOORING REQUIREMENTS AND PROVIDE ADDITIONAL COST SAVINGS

Let's compare TUBALL™ nanotubes – or TUBALL™ MATRIX, which is a TUBALL™-based concentrate based on common carrier solutions – with commonly used conductive agents.

Parameter	TUBALL™ MATRIX	Chopped carbon fibers	Conductive pigments (mica, ATO, etc.)
Working dosage, wt.%	0.1–0.4	1.5–4.0	5–20
Surface-to-ground resistance, Ω	10^4–10^{11}	10^4–10^{11}	10^4–10^{11}
Color opportunity	various	various	various
Required coat thickness	various	~2 mm	various
Can be used without conductive primer	yes	no	yes
Black dots on surface	none	possible	none
Stable resistivity over time	yes	yes	yes
Hot spots (resistance varies on surface)	none	possible	none
Resistance remains stable after abrasion defect on surface	yes	no	yes
Cost of performance	acceptable	acceptable	high

One choice of anti-static additive is chopped carbon fibers. This is a well-known agent, but it has a number of drawbacks.

The first is the limitation of the base coat thickness. Generally, due to the application technology and the average length of the chopped carbon fibers, the base coat thickness is around 2 mm. Also, the performance of chopped carbon fibers can be highly dependent on the quality of mixing and, in many cases, can lead to the appearance of hot spots, which is an area of flooring with an insufficient level of resistance and black dots on the surface. In case of damage of anti-static flooring with chopped carbon fiber, the risk of losing the required property is high.

TUBALL™ nanotubes allow you to significantly minimise or avoid the previously mentioned risks and problems. You can achieve homogeneous resistance with no hot spots and reduced base coat thicknesses, resulting in additional cost savings.

Another common conductive additive is a conductive mica or similar alternative, such as ATO. Conductive mica is a stable industrial solution that doesn't have any of the previously mentioned issues associated with chopped carbon fiber. But at the same time, the working dosage of mica is relatively high, and the cost-performance ratio is much higher than required. Such additives can result in additional limitations to your flooring business.

In contrast, the working dosage of TUBALL™ nanotubes and the cost-performance ratio is much lower, leading to additional cost reduction.

2 reason

TUBALL™ NANOTUBES ARE APPLIED VIA STANDARD MIXING EQUIPMENT

The second reason for choosing TUBALL™ nanotubes as a conductive agent for ESD floors **is the ability to mix TUBALL™ nanotubes into the original flooring compound with no special equipment required to work** at an industrial scale.

OCSiAl has developed TUBALL™ MATRIX – a concentrate of pre-dispersed TUBALL™ nanotubes, which makes the production process easier. It's a well-known industrial approach, which can save time and money for anti-static floor manufacturers implementing a new additive into a flooring system.

TUBALL™ MATRIX 200/300-x
High-dosage concentrates based on polymer carrier and pre-dispersed TUBALL™ graphene nanotubes

TARGET SYSTEMS
Epoxy or PU base coat

PROVIDED PROPERTIES
Resistance 10^4–10^9 Ω

WORKING DOSAGE
0.1–0.4 wt.% against solid formulation

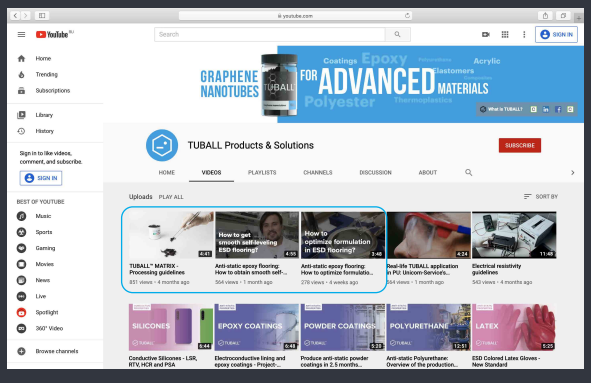
SELECTION GUIDE TUBALL™ MATRIX FOR ANTI-STATIC FLOORS

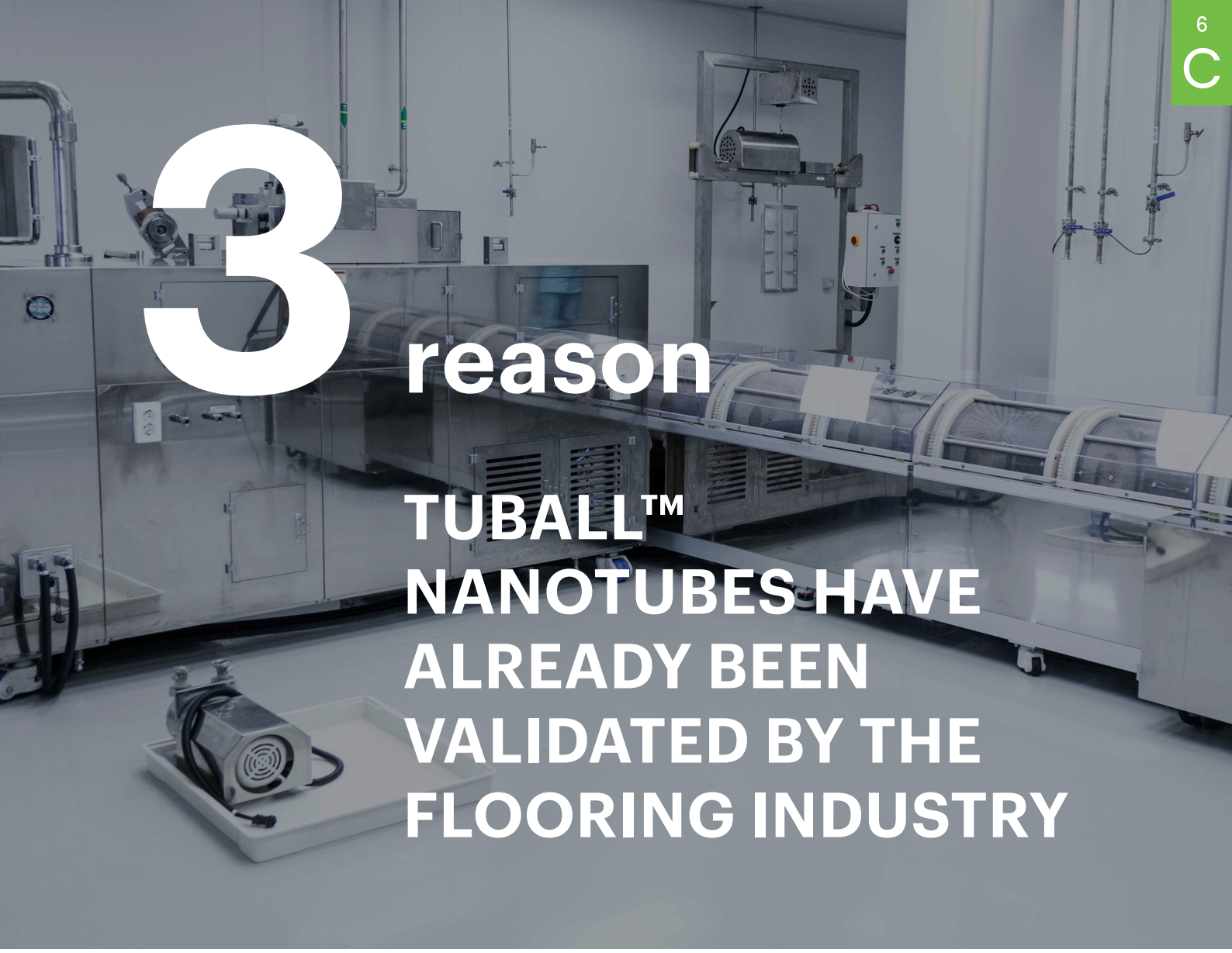
Realizing the complexity and highly competitive nature of the flooring business, OCSiAl has developed a range of nanotube formulations to meet customers' needs. The product list includes epoxy or polyurethane, solvent-free, and solvent-based formulations. To introduce nanotubes into various polymers, only a standard high-speed mixer with the relevant impeller blade is required.

PRODUCT	CONCENTRATE CARRIER MEDIA		TARGET SYSTEM			
			SOLVENT-FREE		SOLVENT-BASED	
	SHORT	FULL	Epoxy	Polyurethane	Epoxy	Polyurethane
TUBALL™ MATRIX 201	Plasticizer	Fatty acid glycidyl ester	■			
TUBALL™ MATRIX 202	Plasticizer	Fatty carboxylic acid ester derivatives		■		
TUBALL™ MATRIX 203	Plasticizer + stabilizing agent	Fatty acid glycidyl ester + ammonium salt of polyolefins based derivatives			■	■
TUBALL™ MATRIX 207	Plasticizer	Alkyl glycidyl ether	■			
TUBALL™ MATRIX 208	Plasticizer + stabilizing agent	Alkyl glycidyl ether + ammonium salt of polyolefin based derivatives			■	■
TUBALL™ MATRIX 301	Surfactant	Ethoxylated alcohol	■	■		

Note: generally, solvent-free systems are suitable for common self-leveling floors (with 1–2 mm thickness), and solvent-based systems are suitable for top-coat or thin floor applications (with <0.5 mm thickness).

More videos and examples of how to apply TUBALL™ MATRIX into flooring formulations, how to achieve conductivity and appropriate self-leveling, and much more can be found at the OCSiAl YouTube channel titled TUBALL Products & Solutions.





3 reason

TUBALL™ NANOTUBES HAVE ALREADY BEEN VALIDATED BY THE FLOORING INDUSTRY

The other reason to choose TUBALL™ nanotubes is its **validation by flooring producers all over the world.**

It is a widespread misbelief that graphene nanotubes are a still scientific novelty. In fact, they have already been validated and adopted into industrial technology. Graphene nanotubes can bring business benefits for flooring producers creating anti-static, self-leveling epoxy or polyurethane floors, including reduced costs, formulation flexibility, and minimizing various risks. TUBALL™ MATRIX graphene nanotube concentrate is available in required industrial quantities worldwide.

ANTI-STATIC SELF-LEVELING FLOORS

Furthermore, sometimes, depending on the request, the conductive requirements can be very strict, such as in the following case example of one of OCSiAl European customers.

PRODUCT

Anti-static self-leveling epoxy floors to protect ESD-sensitive equipment

REQUIREMENTS

- Dissipative (10^7–10^9 Ω) and conductive (10^5–10^6 Ω) ranges
- Permanent, stable level of resistance
- Different colors

TUBALL™ SOLUTION

3–6 wt.% of carbon fiber was replaced with 0.05–0.15 wt.% of TUBALL™ MATRIX 301

KEY BENEFITS

- Permanent, stable level of resistance for dissipative and conductive floors without "hot spots"
- Various base coat thicknesses
- Wide range of colors is possible

An installed anti-static floor with TUBALL™ MATRIX successfully passed resistivity-to-ground and walking tests. It allows both market players, the flooring producer and their client, to expand their business and widen their network of clients.

TUBALL™ MATRIX COMPLIES WITH GLOBAL SPECIFICATIONS

INDUSTRIAL EXAMPLE

Anti-static epoxy floor with 0.1 wt.% TUBALL™ MATRIX 201 meets requirements:

- Resistivity to ground 10^7 Ω (DIN EN61340-4-1, ANSI/ESD S7.1)
- Walking voltage test < 10 volts (DIN EN 61340-4-5)
- No resistivity degradation over time

Zertifikat

Das ESD-Messprotokoll ESDM7641_V1 bestätigt, dass ein in

Ujet Vehicles
Rue de l'Industrie
L-3895 Foetz

mit **Tuball modifizierter Bodenbelag**

die **ESD-Normanforderungen gemäß EN 61340-5-1**
(VDE 0300-5-1) erfüllen kann.

Prüfmethoden nach:
- EN 61340-4-1 (Ableitwiderstandsmessung)
- EN 61340-4-5 (Walkingtest)

Grenzwerte gemäß:
EN 61340-5-1 (R_{gp} < 1.0 GOhm, Walking HBM < 100 Volt)

Andreas Siegert, 29.11.2016, Fötz

Andreas Siegert
ESD – Referent / Koordinator EN 61340
geprüfter technischer Betriebswirt
zertifizierter QM – Auditor ISO 9001

Der ESD-Coach, AS-Consulting, Windthorststr. 8a, 82515 Wolfratshausen, http://www.esd-coach.de

Contact us with any questions or specific technical problems you face, and we will be glad to answer you. If you want to get more information about our product or clarify the optimisation procedure in your case, check our website tuball.com and contact your local OCSiAl representatives.