Technical EPDM Grey

High quality and economical

Technical EPDM Grey compared with the black Recycling Granules is gained in a manufacturing process of an alternative pre-product. This material does not originate from waste rubber as well as most Melos Granules. The material fulfils very high requirements in quality and durability.
Because of the property characteristics, the Technical EPDM Grey is a suitable alternative among recycling granules.

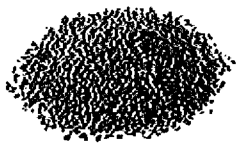
Durable

Sports-functional

Weather-resistant

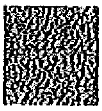
Long-lasting sensible use of resources

Inexpensive



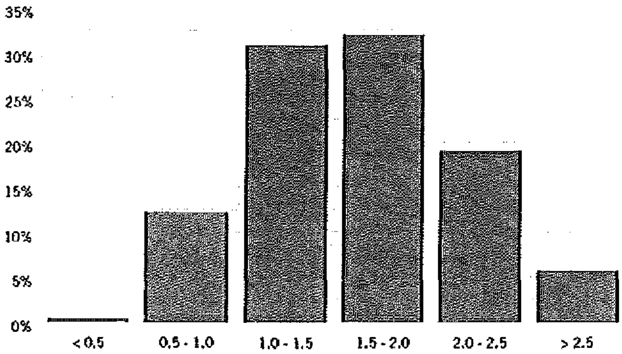
» **Inexpensive**
The Technical Infill EPDM Grey is manufactured from high quality raw materials and is inexpensive.

» Available colours



Grey[1]
Code: 66 0055

» Sieve Curve Technical EPDM Grey 0.5 - 2.5 mm



— Average
Measured according to DIN 53477 with an optical measuring system in mm.

The sieve curve shows the grain distribution of Technical EPDM Grey 0.5 - 2.5 mm.

» Product information

Property	Unit	Value*	Test standards
Density	g/cm³	1.29	DIN EN 1183-1
Polymer content	%	> 20	DIN EN ISO 3451-1
Bulk density g/l (approx. ± 10%)	g/l	475[2]	ISO 60
Hardness	Shore A	45	DIN ISO 7619-1
Grain size	mm	0.5 - 2.5	
Polymer base	EPDM		

*Technically related variations in property and colour and production-related variations as well as innovations and technical changes are reserved. Products shown may differ in configuration from the actual product.

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Terra® XPS

Differences between EPDM based and TPE/TPV based infill systems for artificial turf.

DSM Sarlink® Product

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Topic	Differences between EPDM based ond TPE/TPV based infill systems for artificial turf.
Purpose	This document is meant to give some insights in polymer technology, to be able to judge good from inferior quality and to give a difference between EPDM and TPE
From:	Terra Sports Technology BV. ir. Bart Wijers

Content

Sittard, The Netherlands, 19 July 2006

Terra Sports Technology BV

ir. Bart G.C.J. Wijers
Technical Director

Introduction

The third generation of artificial turf is recognised by long fibre lengths > 40 mm and with rubber granules strewed between these fibres (See figure 1.)

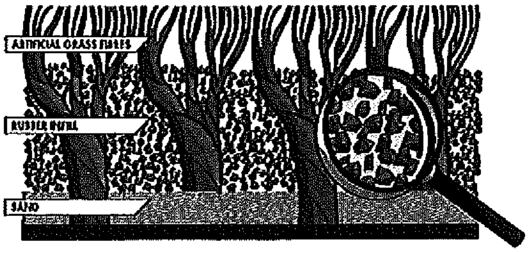


Figure 1: rubber infill in a third generation artificial turf system.

As artificial turf for sports grounds (hockey, tennis, etc.) is already existing for more than 30 years, the technology behind the fibres (design- , production- and polymer technology) is very far and optimised, mostly based on experience and evaluation from the daily practice. But still the fibres are developed and optimised further to have even better sports characteristics and durability and more value of money (which does not always mean: cheaper!)

Rubber infill, on the contrary, is a new component in this system which plays a very important role, like sliding, shock absorption, deformation, ball bounce, grip, rotation of the foot, etc.. Rubber, or the technical word, elastomers, which is applied in an artificial turf system therefore has to meet requirements on different area's:

1. Added value to sport (soccer) characteristics.
2. Durability
3. Safety

In this document a small overview is given about the principles of rubber technology and the difference between vulcanised rubbers (like natural rubber, SBR and EPDM) and thermoplastic elastomers (TPE, TPV).

It is impossible to explain into detail, as there are complete libraries, full of books on rubber technology. Here only principles are given so people can understand the type of material and recognise difference in quality. See the comparison with the car industry:
Only a few know a details about the car technology, but most of the people recognise a new car from a second hand car and, based on reputation, distinguish the reliable brands from the more unreliable brands. But still, also personal taste and preferences are very important in choosing a brand, where every car brand will say they have the best technology, nicest design, etc.

On fore hand one thing can be said which is valid for almost all products:
Quality has it's price, which does not mean that only the most expensive are top products!!

Polymer technology principles

Plastics and rubber are both consisting of long chains of hundred thousands of small atoms which are connected to each other. The difference in characteristics however are determined by the monomers (like one bead or link of a chain that everybody knows) and the co-ordination of these. If you take other links to make the chain you will get other strength, thickness, flexibility etc.

Now with the chain it selves, you still do not have a product which you can use on it self.

Most polymers are build from hydrocarbon monomers:
Example plastics: polyethylene from ethylene, polypropylene from propylene

Example rubbers: poly isoprene from isoprene (synthetic or natural rubber), combination of styrene and butadiene makes Styrene-Butadiene-Rubber (SBR), combination Ethylene, Propylene and a diene makes Ethylene-Propylene-Diene-Rubber (EPDM).

Once a long chain of these monomers are produced, there a few additives which have to be added to this chain to get specific characteristics you need for the product you want to make with this chain:

- Colour: to get a certain colour you have to add a pigment
- UV-stability: UV light is an aggressive initiator of free radicals which are attacking polymer chains (also the case in polymer human cell structure!!). In principle you can compare these radicals as small scissors or knives which have a great ambition to cut the polymer chain on different places. As a result the polymer looses it's strength because of that. Solution: UV-stabilisers, these are absorbing UV-light without forming radicals and/or catching the free radicals and "kill" them before they can harm the polymers. NOTE: also pigments are materials which are attacked by radicals or UV-light, therefore a UV-stabiliser is also protects the pigment which is used for getting the right colour.
- Anti-oxidant: besides UV-light, there are also other sources of free radicals. It goes to far to mention them all, but oxygen is one of these! Therefore besides the UV-stabiliser it is necessary to add, "radical catchers" so they cannot harm the polymer chain.
- Additional components for better processing, forming, better abrasion resistance, better flexibility or stiffness, etc.

Difference rubbers and plastics

Plastics

The difference between a plastic and an rubber is initiated by the co-ordination of the chain. Plastics have a very defined co-ordination which makes it possible that different chains can lay well organised besides each other. This can go so far that a crystalline co-ordination is the results which makes a plastic hard and stiff. But if this material is heated to melting temperature, the chain are able to move and rotate, which results in an undefined, random co-ordination, which makes the total soft and deformable.
Compare plastics with boiling spaghetti: if you boil the spaghetti close connected to each other (as it is packed in the packaging), at the end, everything will stick to each other.

Rubber

Rubbers have a less defined co-ordination chains at room temperature. Therefore rubbers are feeling more soft and is it possible to elongate the material (see figure 2).
Compare rubbers with boiling spaghetti, but with constant moving the spaghetti in the water so it stays loose from each other. When it is boiled and the water is removed, you can move the spaghetti very easily and pull it apart (See figure 2)

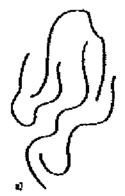


Figure 2: unbounded rubber polymer chains

How to get elasticity and strength then?
So if a soft elastic material is needed for an application (tire, seal, infill) rubbers itself are not having the right strength because it can be torn apart. Therefore the rubbers are so-called "vulcanised". Here a component (sulphur/zinc oxide or peroxide) is added to the rubber which, at high temperatures (> 150 °C) connects the different randomly orientated polymer chain to each other (see figure 3). Therefore double bounds are used (in some places the chain is double in stead of single, one of these double chain flips open, where the vulcanisation connection is connected).
Now the polymer chains are connected to each other, the polymers are still able to move, but limited as a result of 3-Dimensional connections. This results in a still soft, but elastic material which returns in original shape of deformation or elongation.

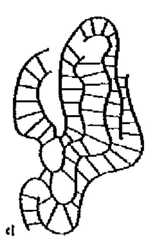


Figure 3: bounded (vulcanised) rubber polymer chain.

There are all kinds of different rubber types: Natural Rubber and all synthetic rubbers like:

EPDM	Ethylene Propylene Diene Terpolymer
SBR	Styrene butadiene rubber
BR	Butadiene rubber

And more than 50 more types....

All of these types have their specific strengths and weaknesses. EPDM is already better resistant against oxidation but has weaker abrasion (therefore EPDM is often used in outdoor seals and sport floorings) but has weaker abrasion resistance (therefore a tyre is not made from EPDM). SBR and Natural Rubber are very abrasion resistant but are much more sensitive for oxidation and UV-light. Therefore Natural rubber (Truck) and SBR (passenger car) is mostly used for tyres, on the condition that it is enough protected by UV-stabilizers and anti-oxidants.

Compare it with cars: for all-terrain driving you will need a 4x4, but for comfortable driving on high-ways you better take a limousine. Both have strengths but also weaknesses.

"SBR" rubber from tyres in artificial turf

SBR rubber is the nick name for all recycled tire material which is used to fill artificial turf systems. But there are much more types of rubber inside. This material is black because carbon black is added to get extra strength and besides that carbon black is a good UV-light absorber!! Because of the strength this material is good to apply in an artificial turf pitch and now there is already some important experience with this material. Lately this material is under discussion because of the higher zinc and Polycyclic aromatic hydrocarbons (PAH) which are present is these materials. The reason why these components are present is:

- Zinc (oxide) for the start up of the vulcanisation reaction. Once the vulcanisation is ready (the connections) zinc has no function any more.
- PAH because high aromatic oils are used to mix the total recipe of a rubber compound which is used to construct a tyre. These aromatic oils contain the PAH's, which stay in the material because they solve very bad in water. In contact with fatty materials, they can however come out. Therefore the oils and fats of the skin can absorb these PAH's.

"EPDM" granules in artificial turf.

In more and more cases, an environmental friendly alternative is asked for SBR material. From the beginning, a granule based on EPDM rubber can be an option. The most important reason is that EPDM, as was mentioned earlier, is already good protected against oxidation. In contrary to what the title says, granules based on EPDM only contain about 20 to 25 weight% EPDM rubber. The rest contains of chalk, processing oil, UV-stabilisers, anti-oxidants, pigments, and vulcanisation materials (sulphur and zinc-oxide or peroxide/starter). With the chose of ingredients (ratio, quality of each component/ingredient) and the production control the most important step in product quality is made. Also environmental friendliness comes only with careful selection of ingredients!
After mixing the ingredients together, the compound has to be vulcanised and after that it is granulated into rectangular (undefined) shaped materials with a broad particle size distribution.

Are EPDM granules of good quality and environmental friendly?

Yes, <u>BUT</u> only if, as already mentioned, the producer is selecting and using first class ingredients and good production method's. There also the problem comes in. New materials have a higher cost price and also the processing has a significant cost, and therefore the price of EPDM based material is significant higher than "SBR" granules. Just like in every other industry, it is focussing to reduce costs to lower the production cost to lower the price or increase margin. In doing this, the producer has to make the right choices and control the final product quality.
Unfortunately, some producers are going too far in cost saving by:

1. using second grade (off specification) EPDM polymers. This are polymers which where not of enough quality to set in the market as first grade.
2. Save on the quality and amount of the –expensive-
    a. UV-stabilisers,
    b. Anti-oxidants
    c. Pigments
3. Putting too high ratio's of the cheaper chalk in it, so the rubber-characteristics are turning into chalk characteristics.
4. In case of recycled EPDM material (e.g. old window-seals, motor compartment parts, etc.), you cannot be sure what ingredients and raw materials are used. Simply believe in the word "EPDM" as environmental friendly is therefore very dangerous. If you want to be sure to test a

sample from this material, of which it is unknown if it is a representative sample!! For example: als EPDM can contain zinc (from vulcanisation process) and PAH's.

Ad. 1: As a result, depending on the "off-specification- reason for the EPDM, each supply or even in one supply for one pitch, the product quality can differ from good to bad. Because of this inconsequence, the playing characteristics, but also durability of the product can be in danger. There are pitches installed were not EPDM rubber was used but EPM. This material has no double bonds and therefore the vulcanisation is difficult to impossible. As a result, within one year all infill granules turned into one solid layer.

Ad. 2a and b: In case not the right or enough UV-stabilizer is used, UV-light will earlier attack the pigment and the polymer, where as a result the material gets harder, up to a hardness like stone. In the same time, the material has a higher abrasion.

Ad. 2c: Not the right quality of pigments leads earlier to discolouring.

Ad. 3: Since the price of new EPDM polymer has increased with more than 60 to 70% in the last two years, some manufactures save on the amount of EPDM rubber and increase the amount of chalk. There is however a maximum in the ratio of chalk to rubber, after that the material will be too weak and too abrasive.

Ad. 4: Never use the word EPDM or TPE as a product quality and safety standard. Example: A car is not always a good car. The manufacturer has to his best to construct one of the expected quality level. A 10 year old car is still a car, but not according to latest technology and environmental pollution.

Thermoplastic Elastomers (TPE)

The development of thermoplastic elastomers has started more than 30 years ago, where an answer had to be found on two disadvantages of rubber:

1. more stage production with high energy costs
2. recyclable at the end of the life span. Vulcanised rubber is not recyclable; granulation or burning for energy are the best option.

DSM, as a producer of rubber and plastics, was one of the first which found the solution in a combination of plastic and rubber. Coming back to the plastic, which has a good co-ordination of the chains at room temperature and the soft, but deformable unvulcanised rubber, a combination of both was developed where the plastic parts (H in figure 4) holds the total compound together (without vulcanisation) and rubber gives the softness (S in figure 4). The combination leads to elasticity, where the plastic remembers the original co-ordination and goes back to this situation after relaxation (see figure 4). Thermoplastic Elastomers do not need to be vulcanised and therefore one process step and energy is saved; even better, exactly the same production method as for plastic industry can be used, which saves on investments.

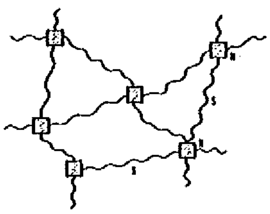


Figure 4: Schematic overview of a thermoplastic elastomer.

At the end of the life-span TPE's can be recycled, by heating up the material up to the melting temperature of the hard thermoplastic segments (>180 °C); then, the total material mixture becomes viscous and therefore the material can be processed and/or 100% recycled. By cooling the material the co-ordination of the plastic segments is formed again, and the material becomes elastic again.

Production of TPE:

TPE compounds are mixed in a (double screw) extruder (a cylinder with two rotating screws, which are kneading all ingredients) (see figure 5). At the end the viscous melt material comes out through a plate with small holes. Since this plate is part of a water-container, the material cools down to the solid phase immediately. On this point an underwater rotating knife is cutting the material into small

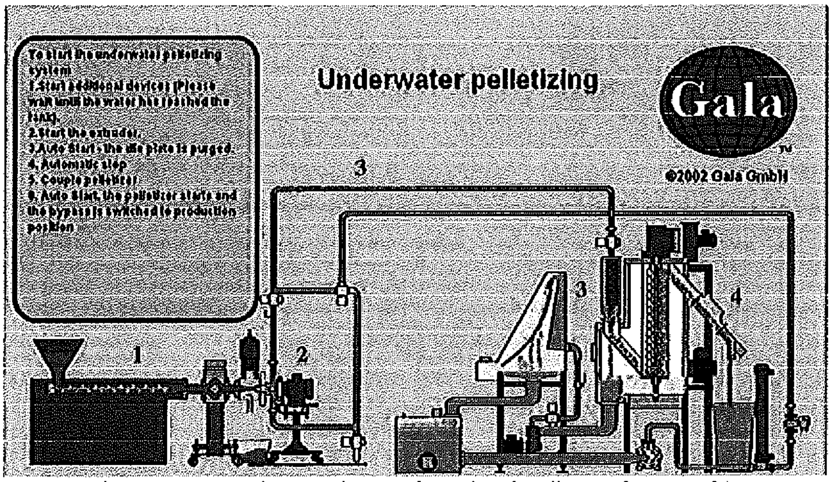


Figure 5: schematic overview of TPE production (picture from http://www.gala-europe.de):
1: Extruders mixes all ingredients
2: Underwater rotating knife is cutting granules (red spots)
3: Granules are transported and separated from the water (blue)
4: Granuels are dyed and packed in big-bags

granules. Since the water in the water container is constantly refreshed (to control the water temperature but also to transport the granules, only the granules have to be separated from the water and dried. (see figure 5)

Good quality TPE?

What counts for the ingredients for EPDM counts also for TPE. Also in case of TPE is extremely important that one chooses the right ingredients like the TPE-type, first grade of this TPE-type, chalk amount, UV-stabilisers, anti-oxidants, pigments.

So, on product quality a good quality TPE infill can only be produced, on the condition of high quality ingredients and good production control. One has to be careful that low prices does not lead to decrease in quality to levels that are absolute unacceptable, because of a live span of the product of only a few years, with examples of one year!! Terra XPS is guaranteed to be consistent in quality for 8 years sunny climates (South of Europe) till 10 years in average to cold climates (e.g. Middle and North Europe)

How can good quality TPE infill, like Terra XPS, be distinguished from bad quality:

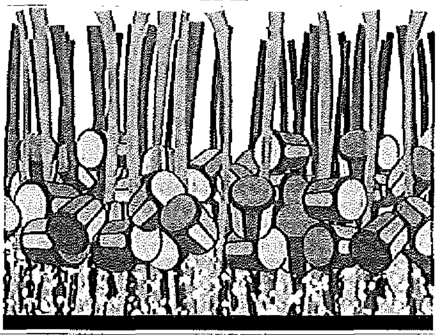
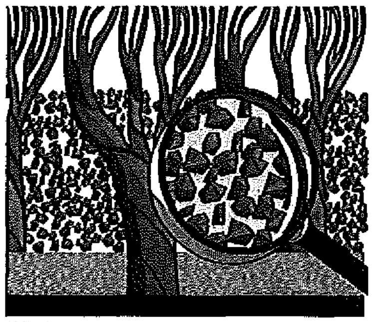
1. Most important: the producer of infill must be able to show that they are in control of product quality and environmental impact, which can be guaranteed.
    a. Intense weather-simulation tests and results. No significant discoloration is allowed (more details can be found in our product data sheet) (FIFA test)
    b. High temperature testing (test plates of new material are kept in an oven (7 days at 100 °C). After this test the tensile strength, elongation at break and hardness of the material may not be chanced (typical rubber check)
    c. High pressure deforming: after 72 hours at a pressure of 200 Bar, the material must come back in its original shape! (FIFA test)
    d. Abrasion test must show if dust is produced with the granules, before and after climatic simulation.
    e. The producer must be able to guarantee that only first grade ingredients are used, and that these are used for all supplies!!
2. Based on experience FIFA, the Italian LND, Labosport and ISA Sport have intense product quality check procedures. Ask for reports of these tests.
3. Check on differences between small samples and the real supplies!

In the end, one has to trust the producer and supplier of the infill material. Therefore, just like is done for most purchases (private or Business to Business), look or ask for the reputation of the supplier, if it is a sustainable company, what the sales conditions are, what is the (after-sales) service level, etc.

What is the advantage of TPE in comparison to EPDM?

Since DSM is also world leader in the production of EPDM polymer, there is a lot of knowledge about compounding technology. If polymer engineers would have to design a compound for an EPDM-based granule to be used in an artificial turf system, the price would be at a higher level than the price level Terra XPS!!!

Based on the situation that an EPDM based granule is at the same quality and durability level as Terra XPS, still Terra XPS has the following advantages:

TPE	EPDM
	
Shape & Size: since the shape and size of Terra XPS is fully uniform, this infill cannot compact, and therefore stays loose. The advantage of this is for the player; just after installation, but also after years, the studs of the players' shoes still find good grip, in combination with good rotation..	Rectangular shaped EPDM granules, just like "SBR" granules, are resulting in a very open structure just after installation, but in time, these granules will shove "in" each other, so significant compactate. As a result, the studs of the players'shoes are not penetrating intor the pitch as in natural turf, and therefore have less grip. Also rotation of the food is harder because the material does not move so easy.
Because the polymer chains are saturad hydrocarbons (no double bonds any more), the material is better resistant to radical attacks.	The polymer chain of EPDM are unsaturated hydrocarbons (double bounds in the chain), which are very sensitive for radical attacks. Still with good UV-stabilisers and anti-oxidants, the risk is higher that the polymer is attacked. As a result the EPDM granule gets harder.
Because the infill layer stays loose in time, the playing characteristics are very consistent. So shock absorption, ball bounce and deformation will stay more constant in time.	Because of compactation of the granules, playing characteristics will decrease in time. So shock absorption, ball bounce and deformation will change.
Because Terra XPS do not have to be vulcanised, also the chemicals that are used for vulcanisation are not present in Terra XPS. Even the softening material is medical approved, which means that it can be used for medical applications. Therefore, as is proven in several independed analysis, Terra XPS has the highest score on safety for environment and health.	EPDM, as a rubber, still has to be vulcanised, so or chemicals for sulphur vulcanisation (sulphur and zinc oxide), or peroxide + additional chemicals, have to be added, having an negative effect on the safety for environment and health. However, as the concentrations are controlled to lower level compared to "SBR" material, it is probably more safe for environment and health compared to "SBR".

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Sports-functional

Weather-resistant

Long-lasting sensible use of resources

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The Technical Infill EPDM Grey is manufactured from high quality raw materials and is inexpensive.

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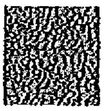

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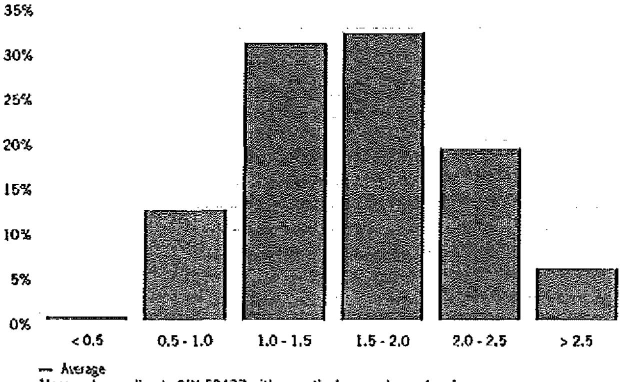

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