Közgyűlés
Paradigmaváltás a szálas struktúrák megítélésében
Textiltechnológia újdonságok, kihívások és megoldások

Tört R S

Sokaság

3D

3D nyomt

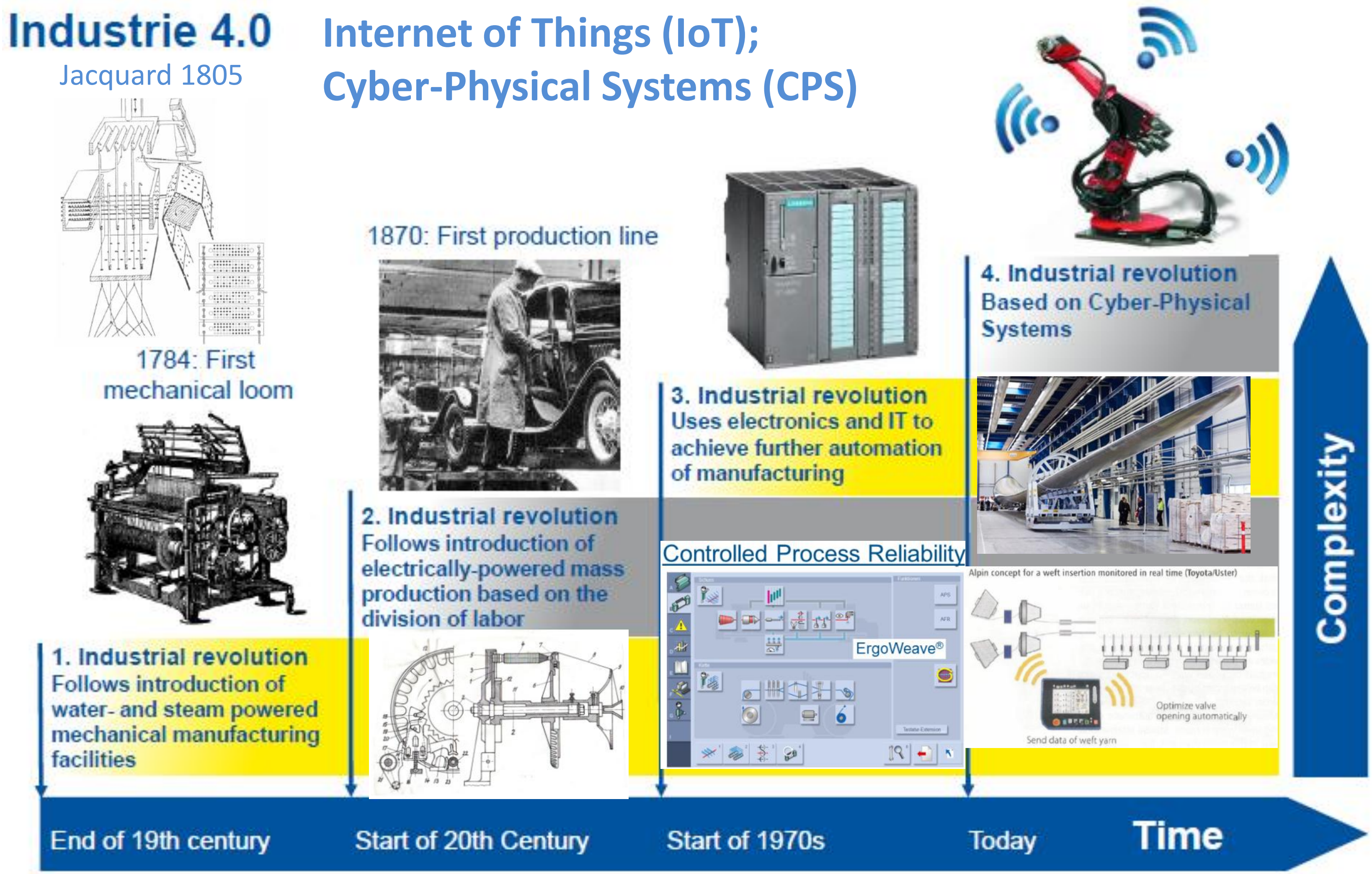
Bionik

Paradigmaváltás a szálas struktúrák megítélésében
Textiltechnológia újdonságok, kihívások és megoldások

Szabó Rudolf

TMTE Közgyűlés 2017. 05. 18.

4. Ipari forradalom



2010

Sustainable Fashion

Function is fashionable, with shapewear and sportswear becoming key trends.

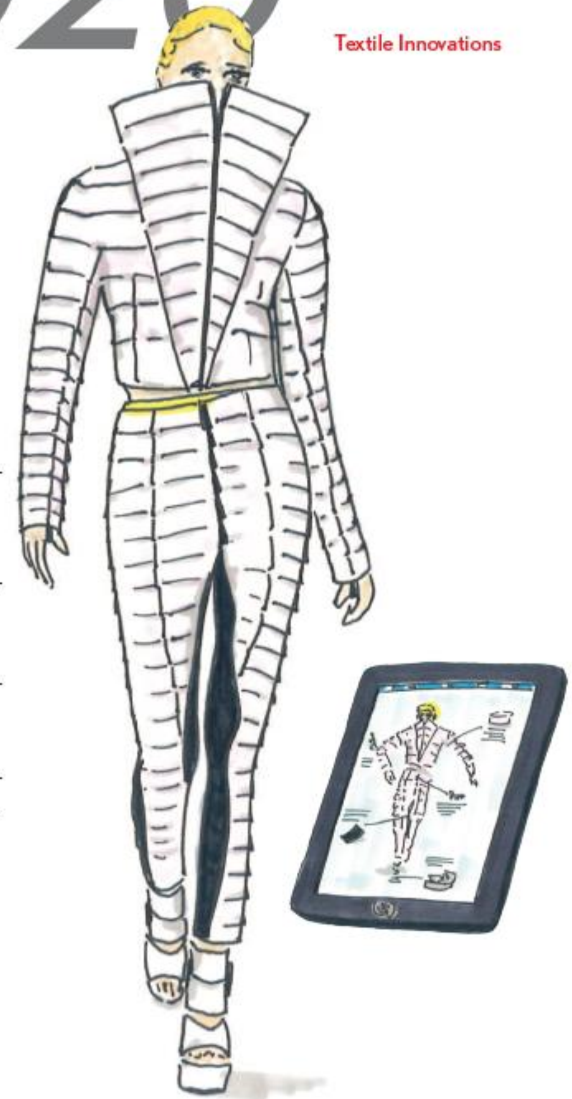
Demand for environmentally-friendly consumer products is growing.

Social networks are changing the style and pace of communication. Internet shopping claims a large and growing share of retail sales.

Mass migration is a challenge for international politics.

2020

Textile Innovations

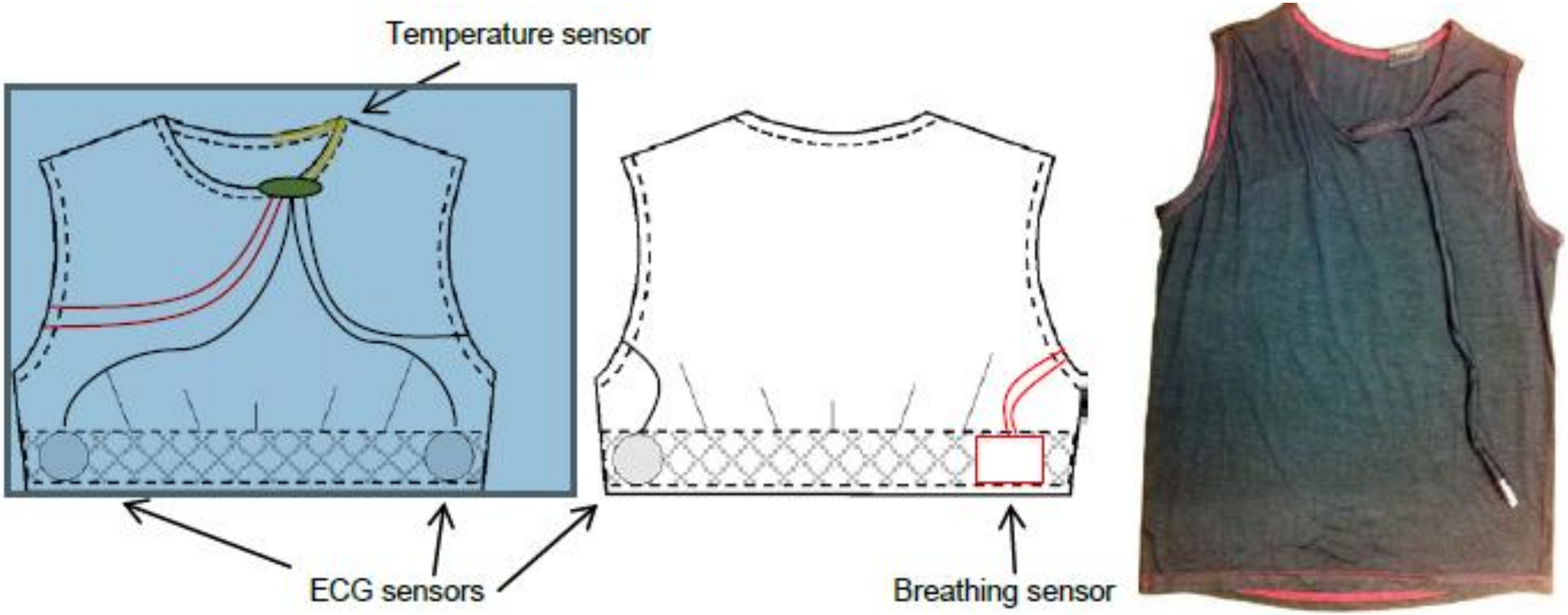


Wearable electronics will become a bigger trend. The demand for innovative functional fibres is increasing.

Liberalisation of markets continues, promoting further globalisation.

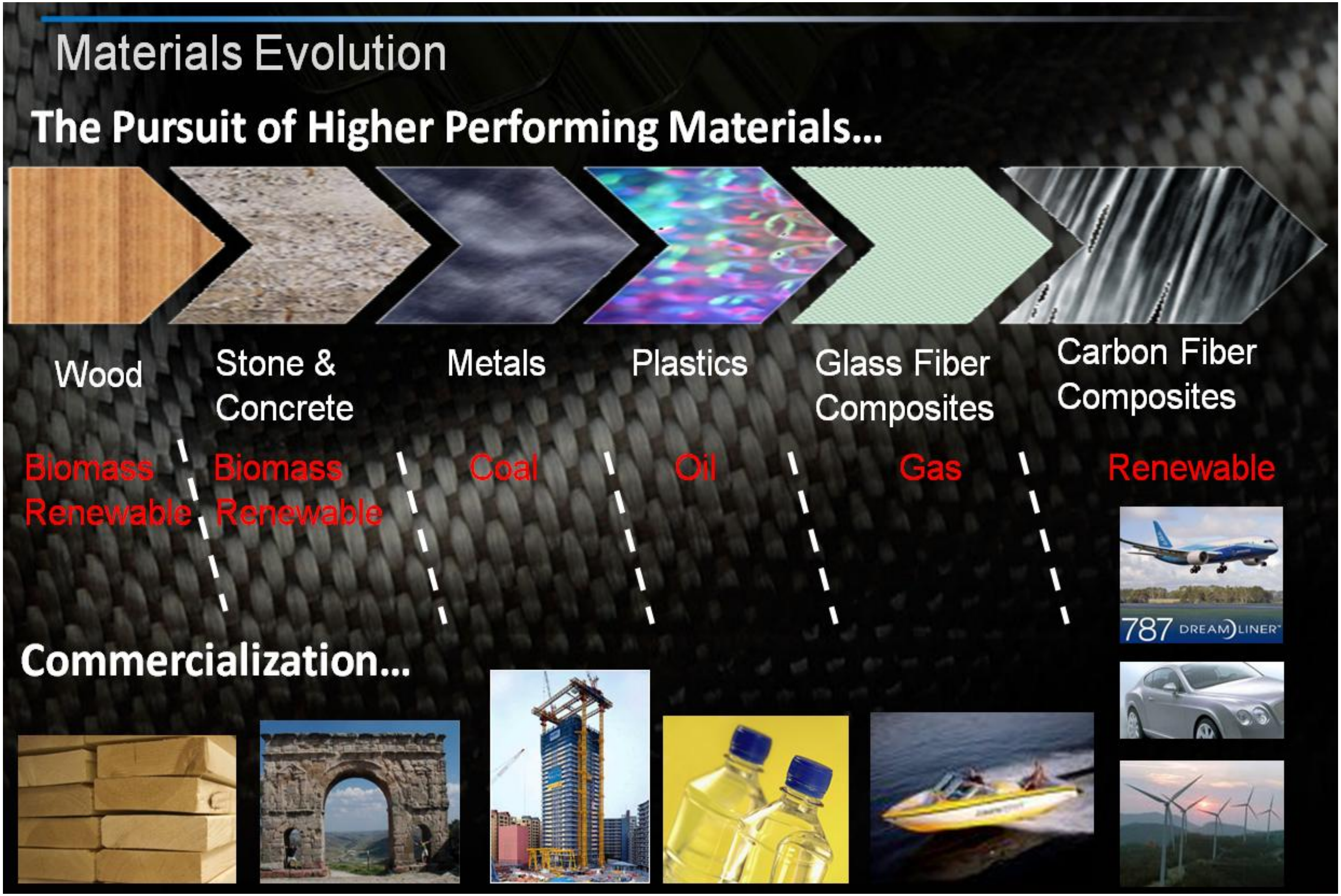
The 'Information Society' just keeps on expanding.

Asian countries, especially China, retain their importance, as strong growth continues.


Temperature sensor
ECG sensors
Breathing sensor

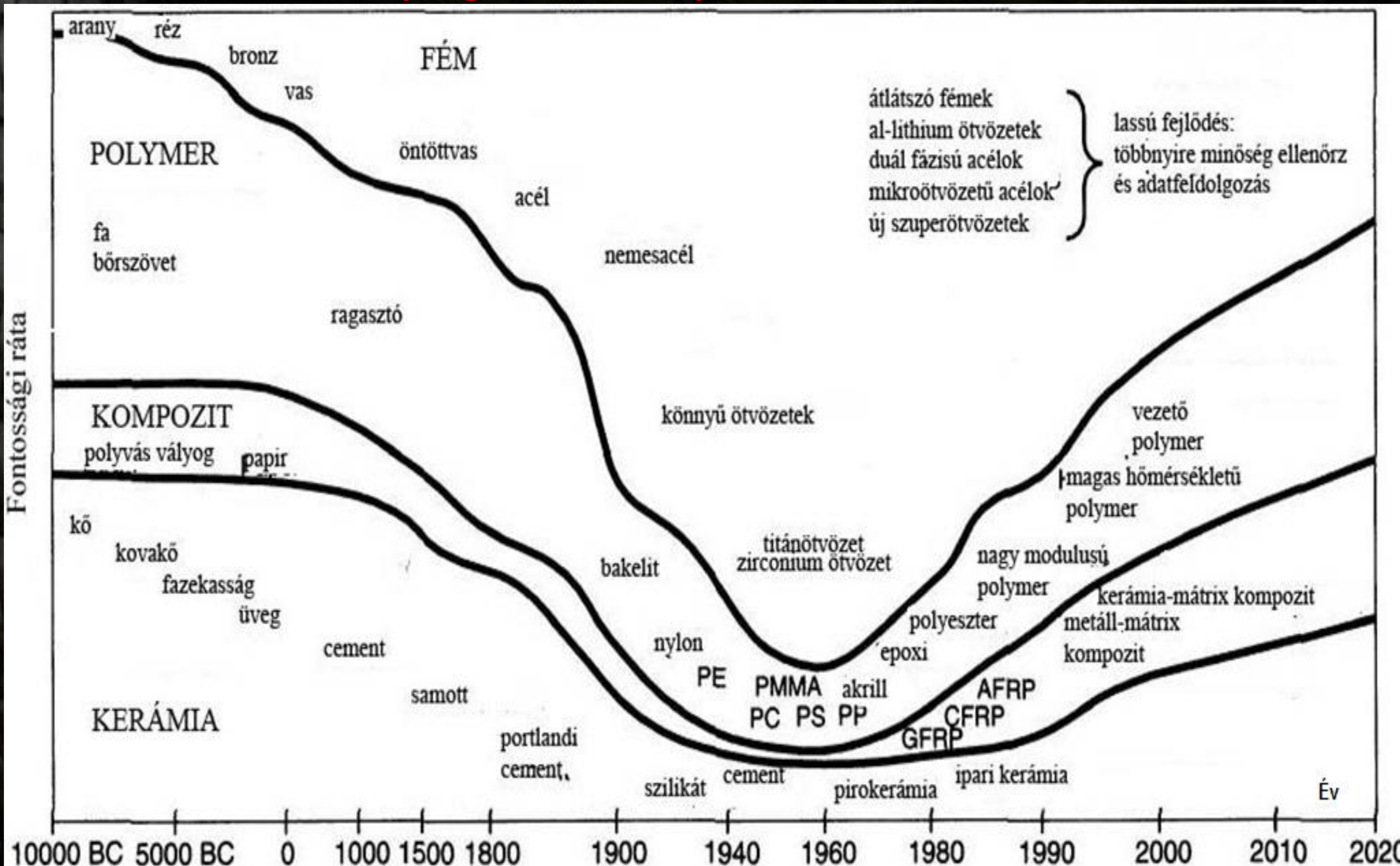
Technical textiles offer inspiration for fashion designers and help

IoT Internet of Things
World Textile Information Network
(WTiN) is to launch IoTex magazine

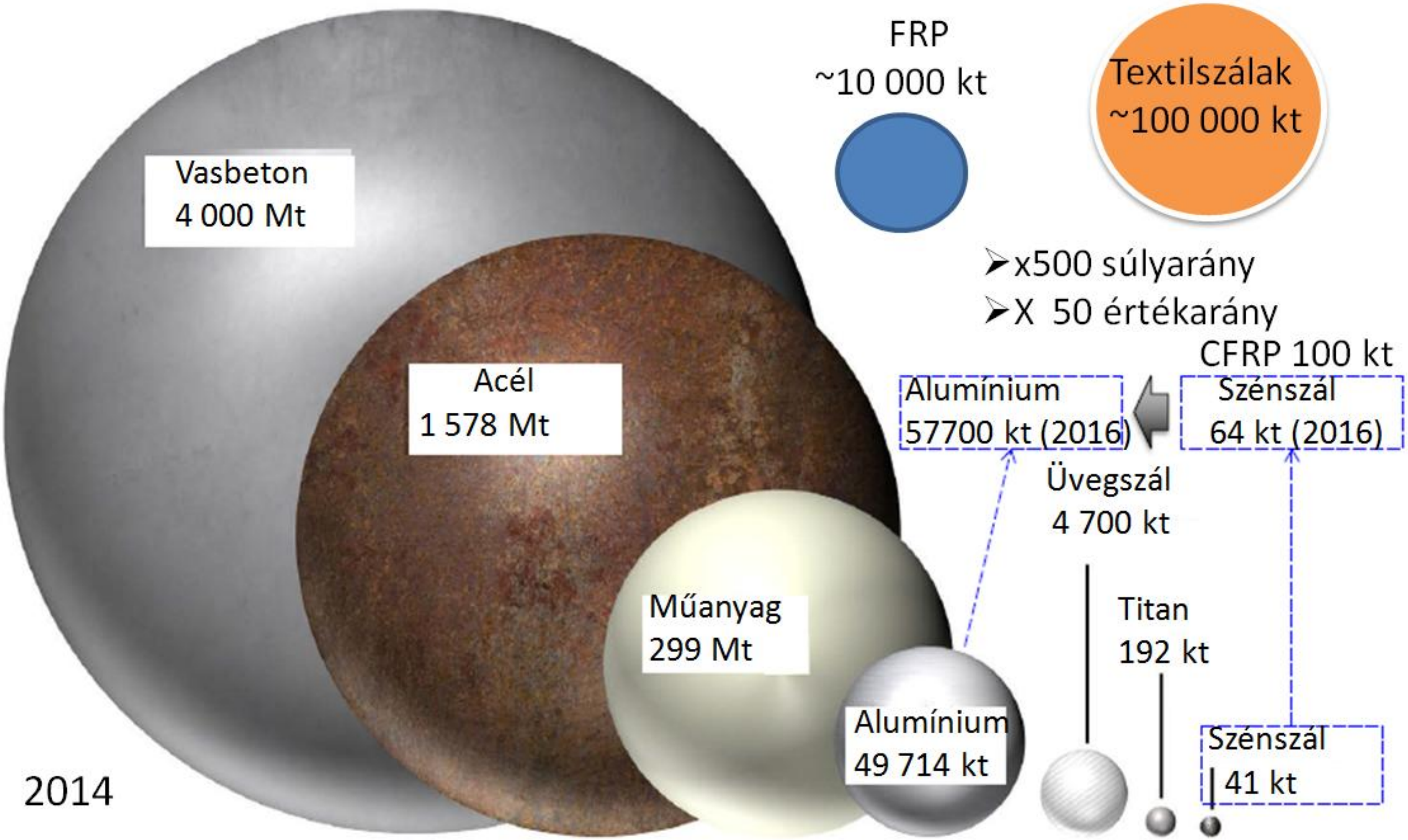


Materials Evolution
The Pursuit of Higher Performing Materials...
Wood
Stone & Concrete
Metals
Plastics
Glass Fiber Composites
Carbon Fiber Composites
Biomass Renewable
Biomass Renewable
Coal
Oil
Gas
Renewable
Commercialization...
787 DREAMLINER

Különböző korokban az ember által használt anyagok arányának változása



Szerkezeti anyagok megoszlási aránya (2014) szénszál ill. CFRP és az alumínium összehasonlítása 2016 –ban

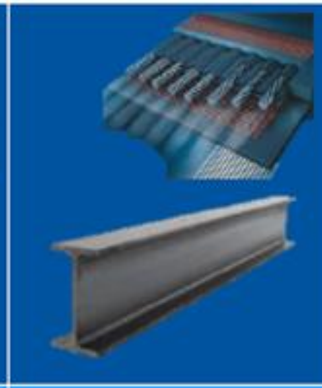


Nehézség → erősség

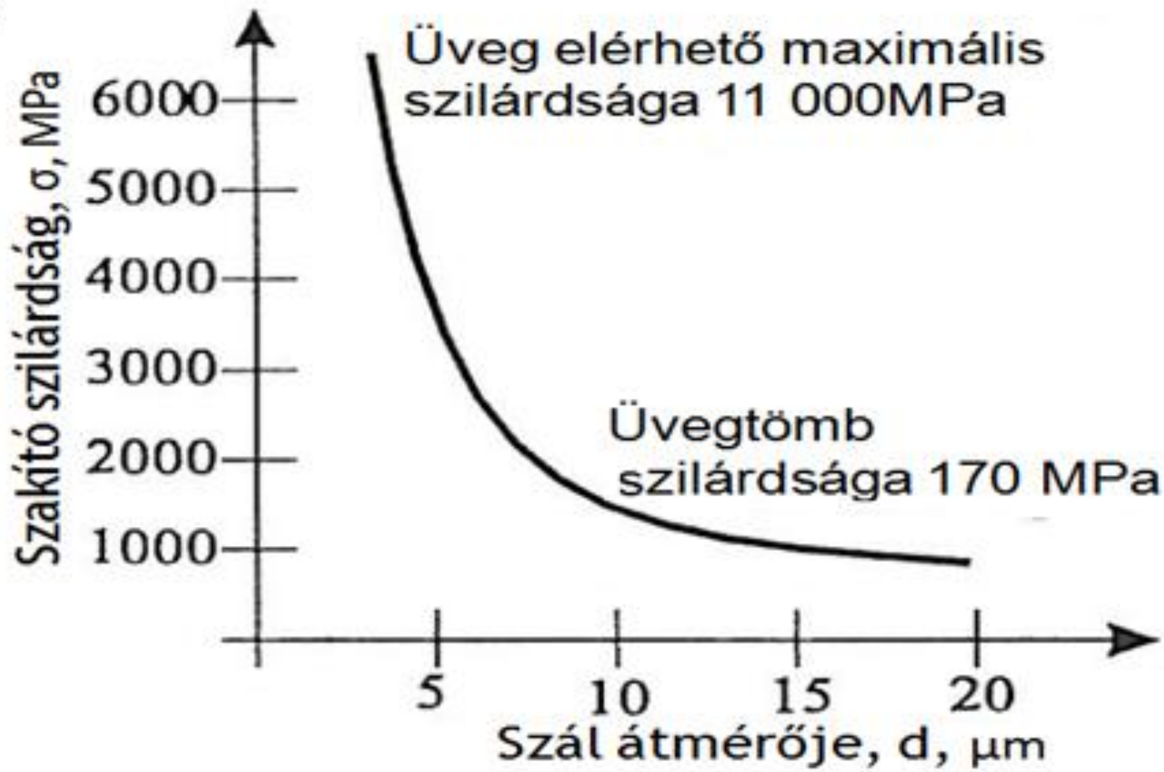
helyett

Könnyűség → erősség

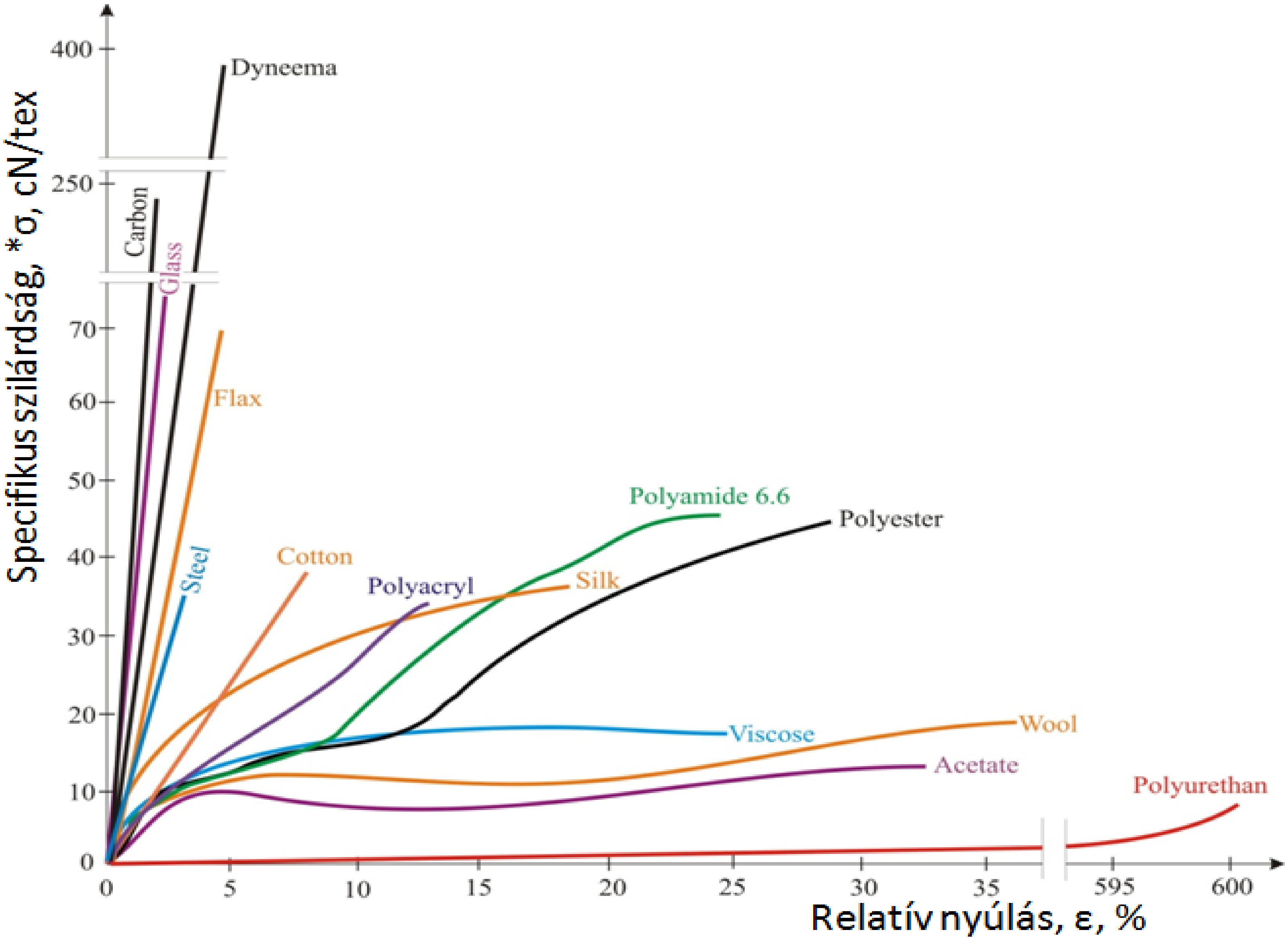
Szerkezeti anyagok szál és tömb formájú szilárdsága

	Szén	Acél	Üveg	Polimer
				
Sűrűség	1.8 g/cm^3	7.8 g/cm^3	2.5 g/cm^3	1.0 g/cm^3
Szilárdság Szál forma	7.1 GPa	4.0 GPa	4.0 GPa	3.20 GPa
Szilárdság Tömb forma	0.1 GPa	1.4 GPa	0.5 GPa	0.03 GPa

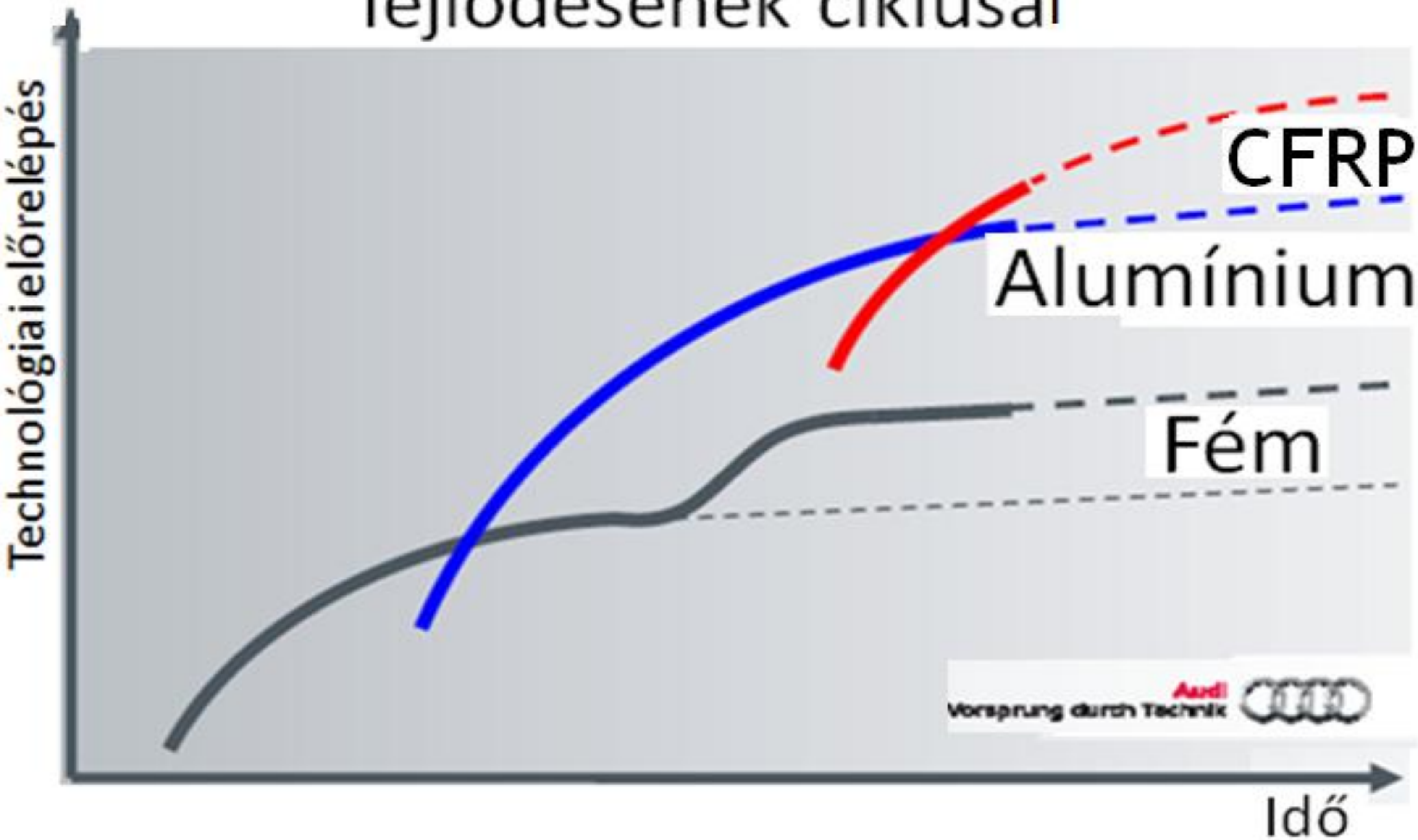
Szálas szerkezetek jellemzői



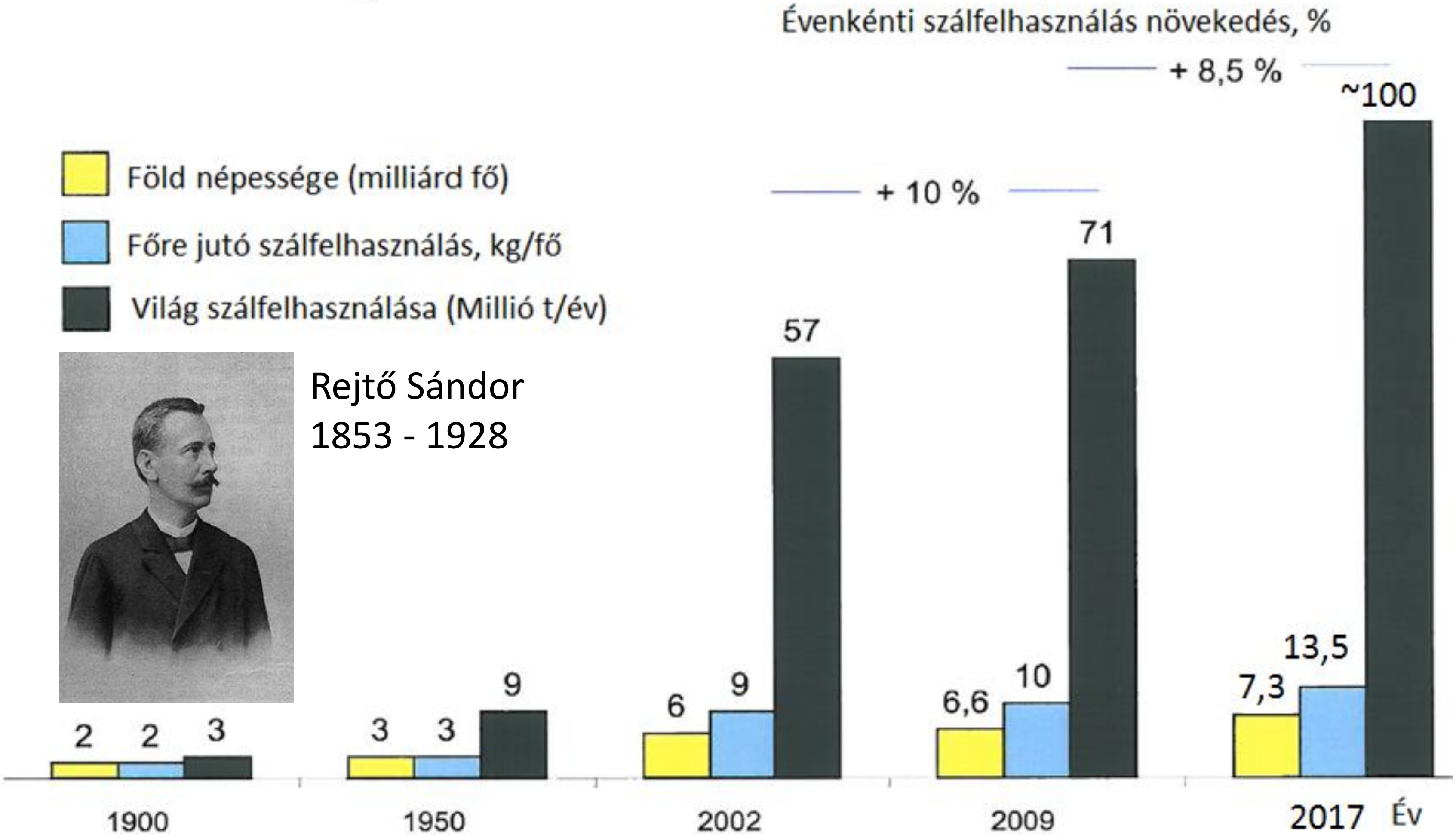
Különböző szálak specifikus szilárdság-nyúlás diagramja



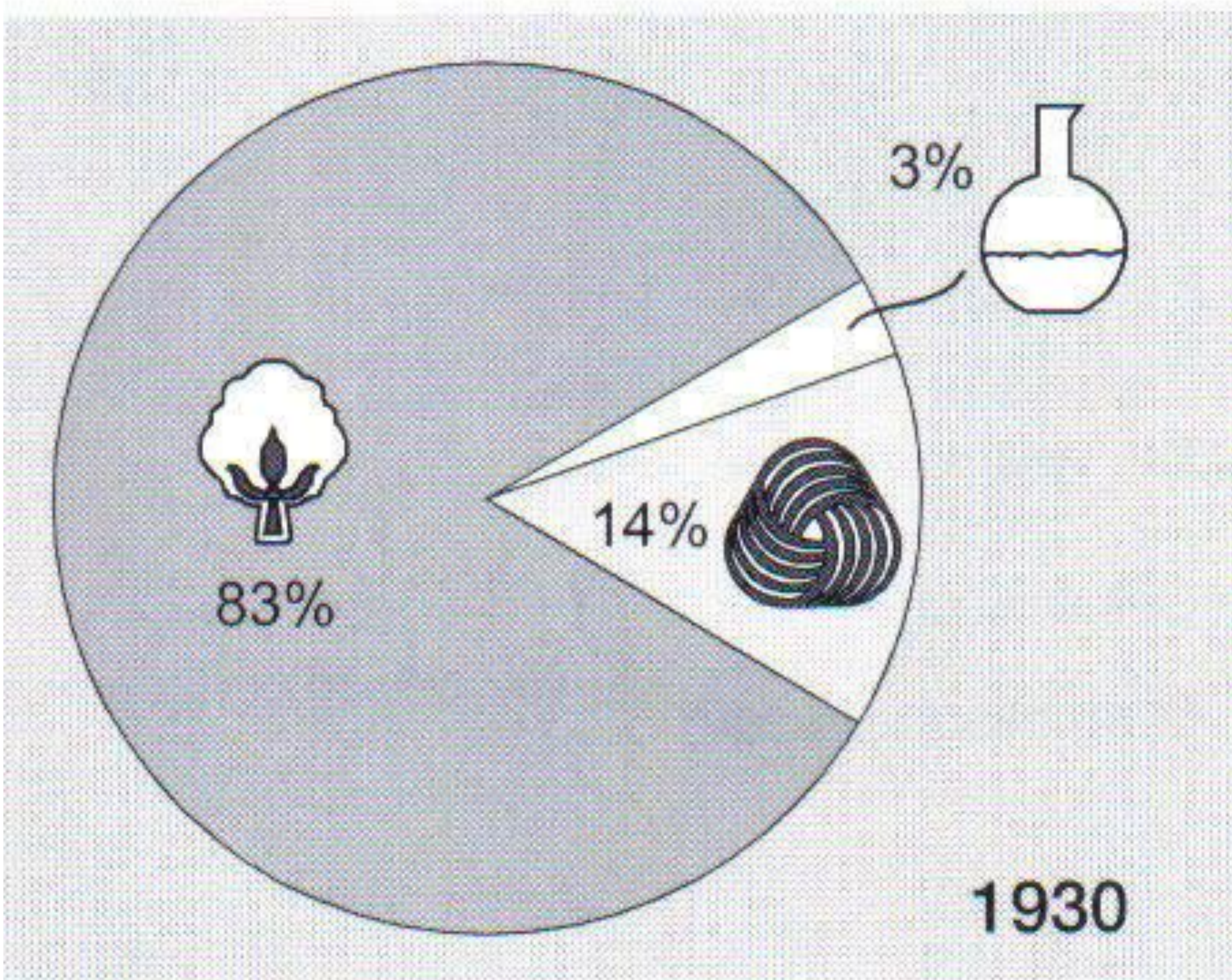
Anyag-használat technológiai fejlődésének ciklusai



Föld népessége, az egy főre eső szálfelhasználás és a világ száltermelés időbeli alakulása



Rejtő Sándor
1853 - 1928



3 Weltmarktanteile 1930

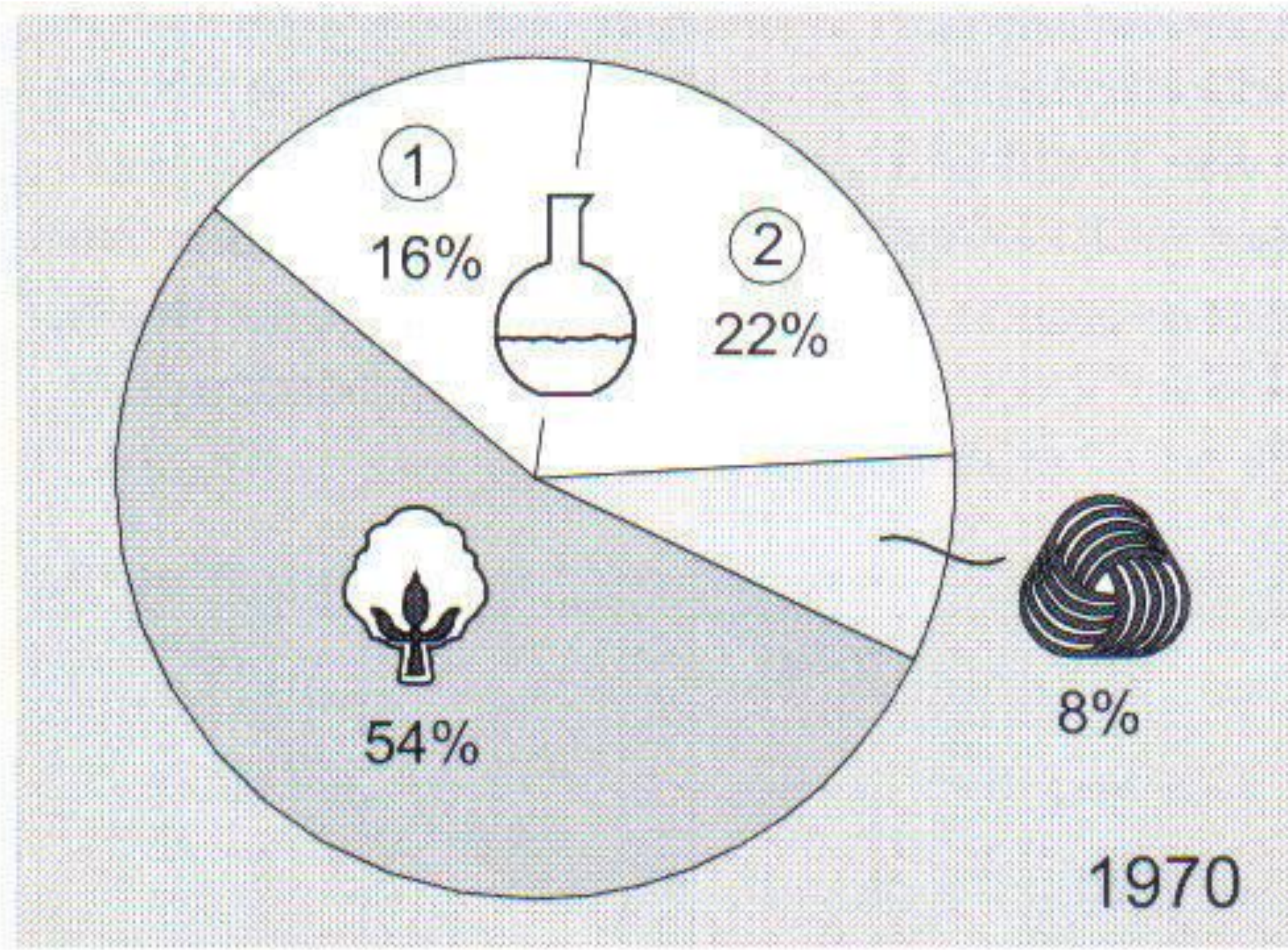
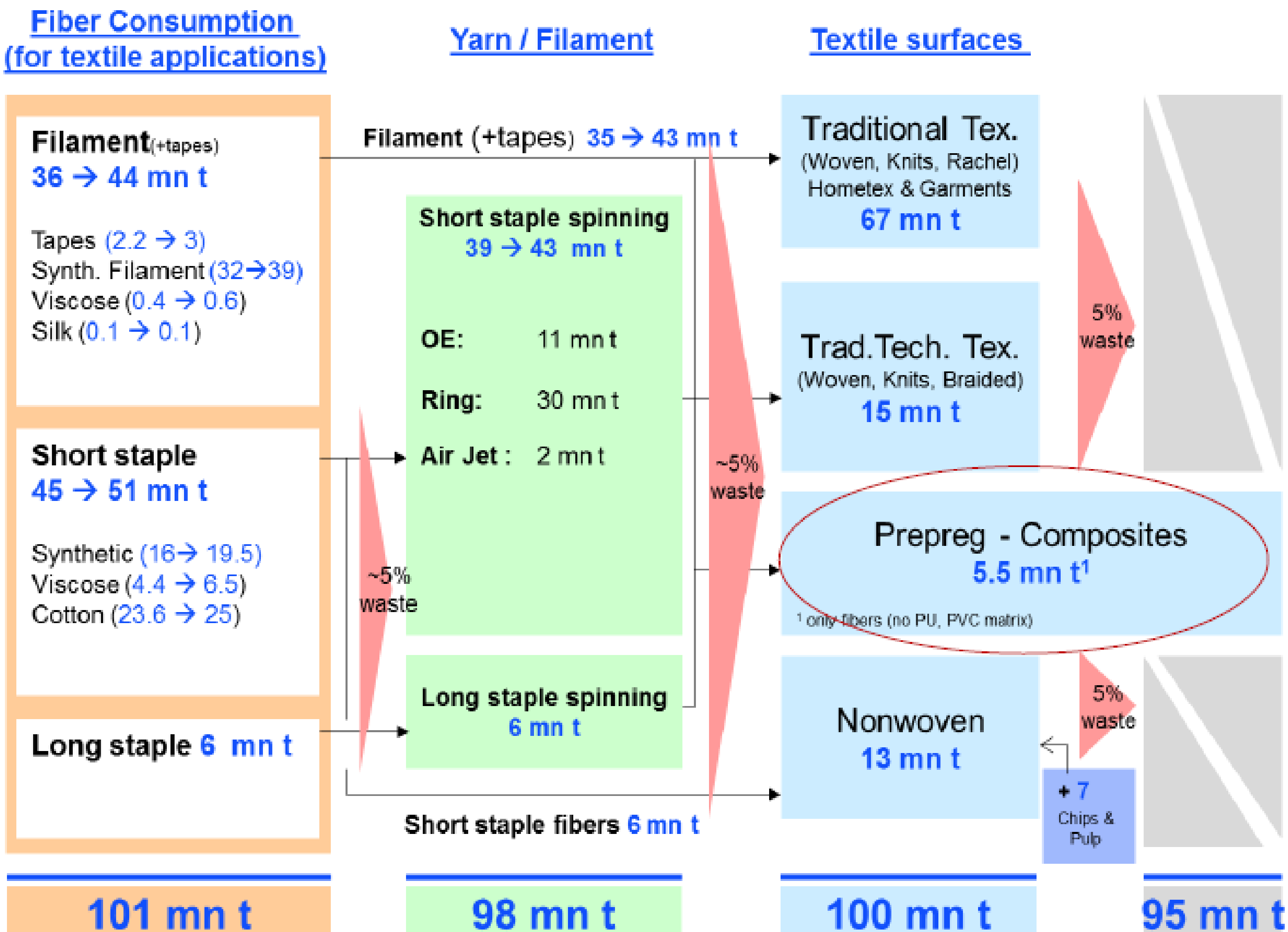


Bild 4 Weltmarktanteile 1970

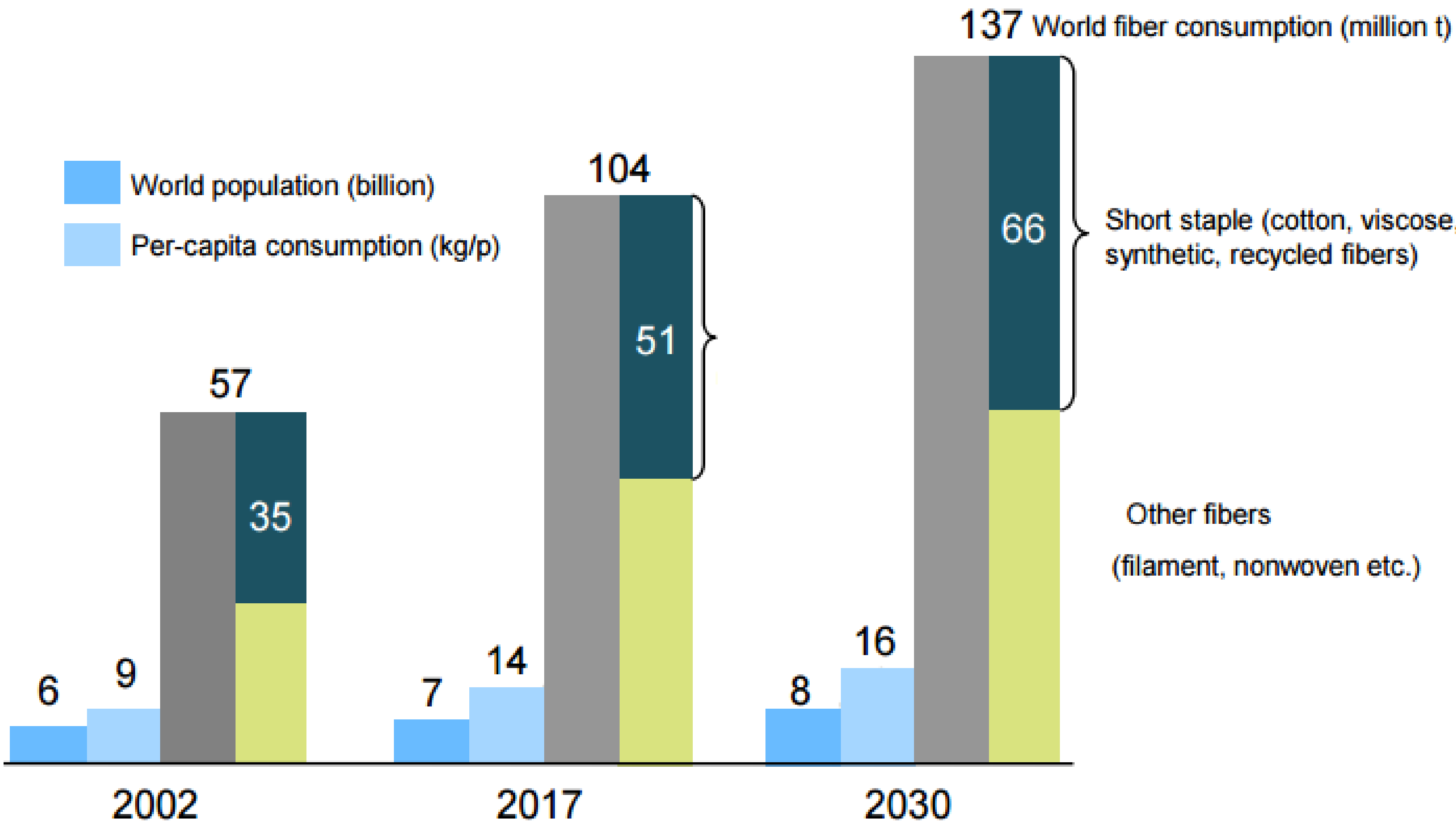
1 Cellulosische Fasern

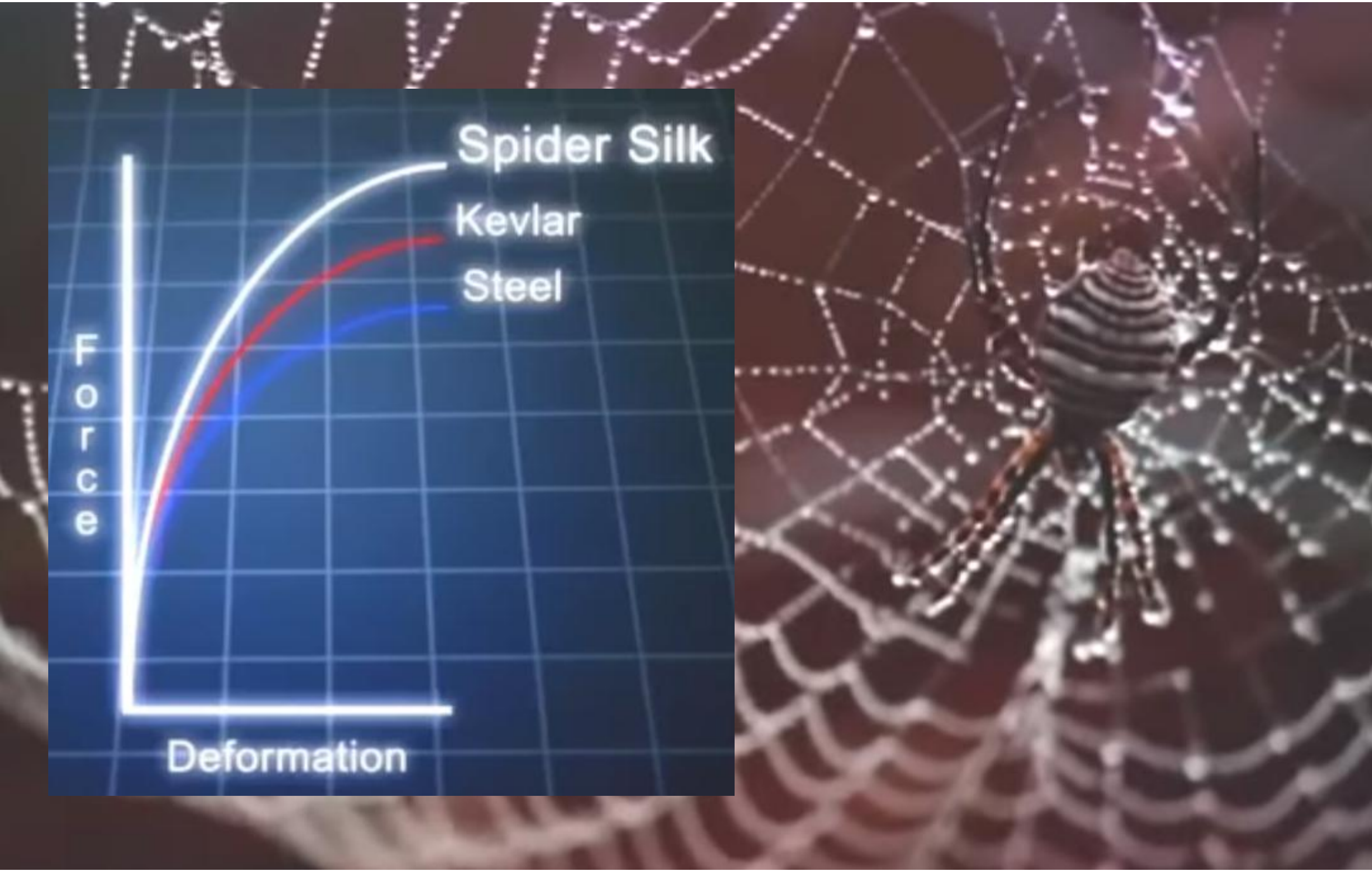
2 Synthetische Fasern

World wide textile added value chain 2020



World population and fiber consumption growth

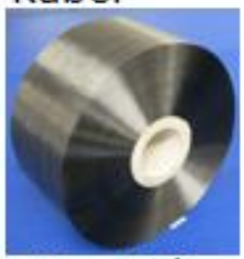



Spider Silk
Kevlar
Steel
Force
Deformation

Carbon fiber – Szénnszál

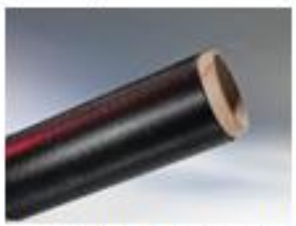
Tow – Kábel

Chopped – Aprított



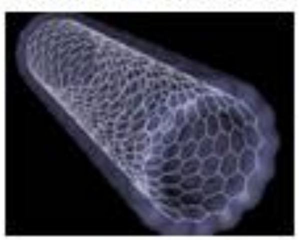
Spread Tape –Terített szalag

Milled – őrölt



Staple yarn – Font fonal

Compound- Granulátum



Nano fiber tube - Nanocső

Glass fiber – Üvegszál

Roving – Kábel

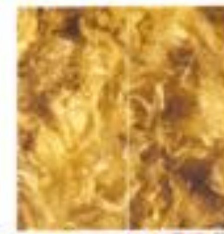
Yarn – Fonal

Chopped – Aprított

p-Aramid

Kábel/Filament

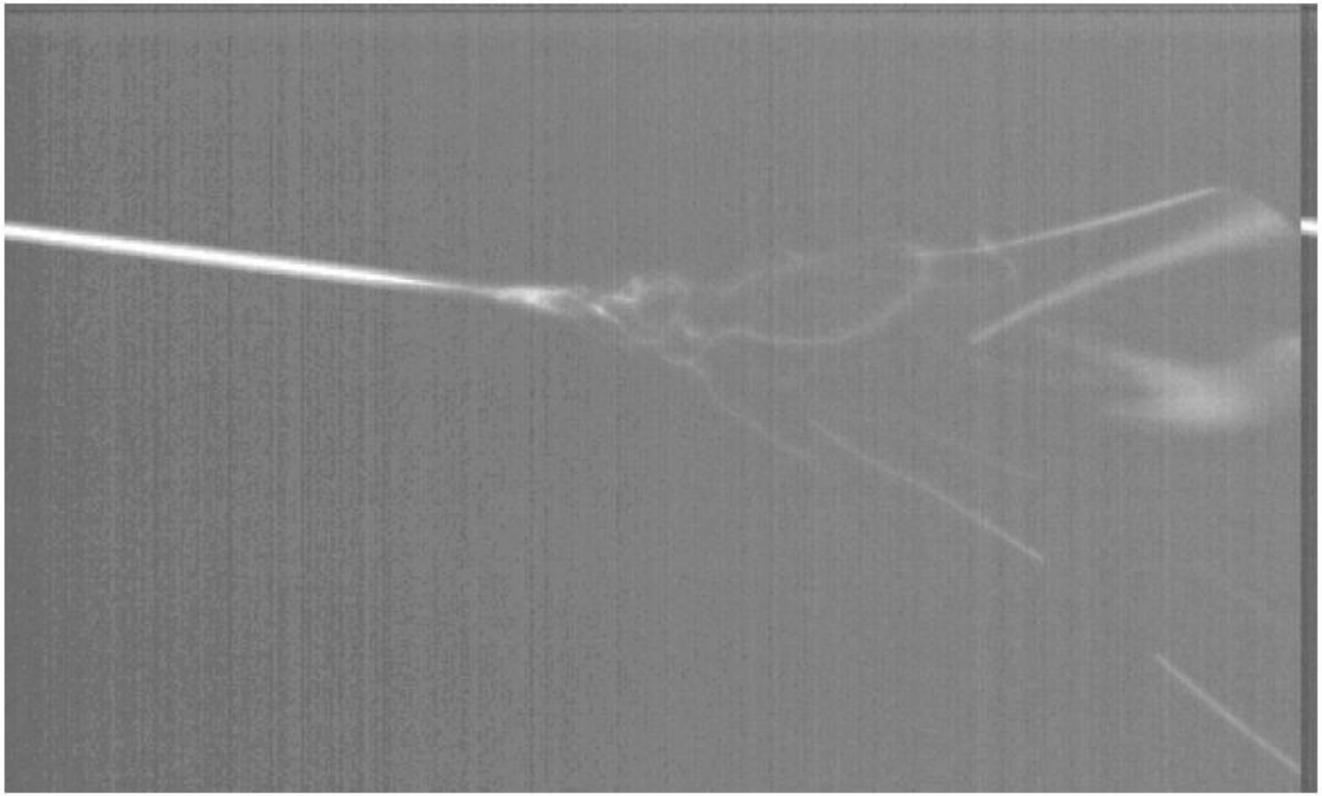
Chopped – Aprított



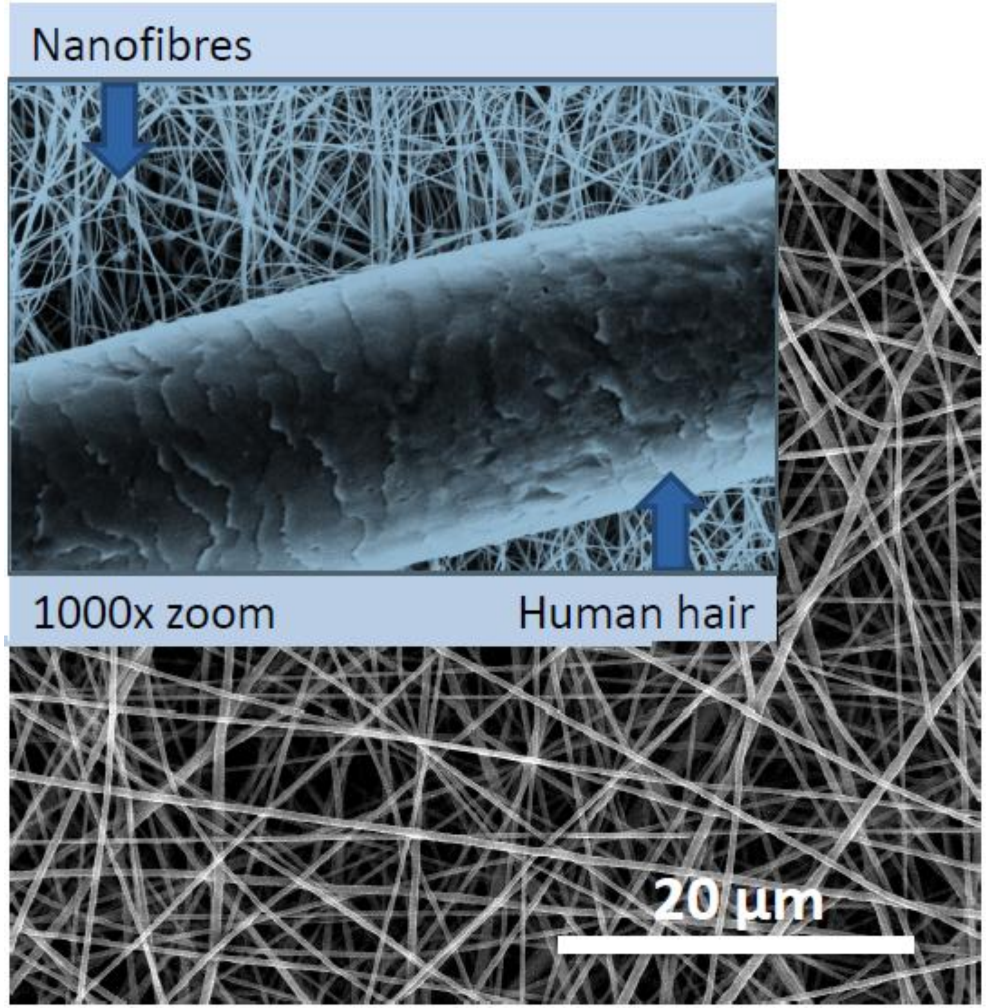
Staplle – Vágott szál


Pulp fiber – Foszlatott szál

Electrostatic Spinning



Nanofibrous nonwovens have unique characteristics



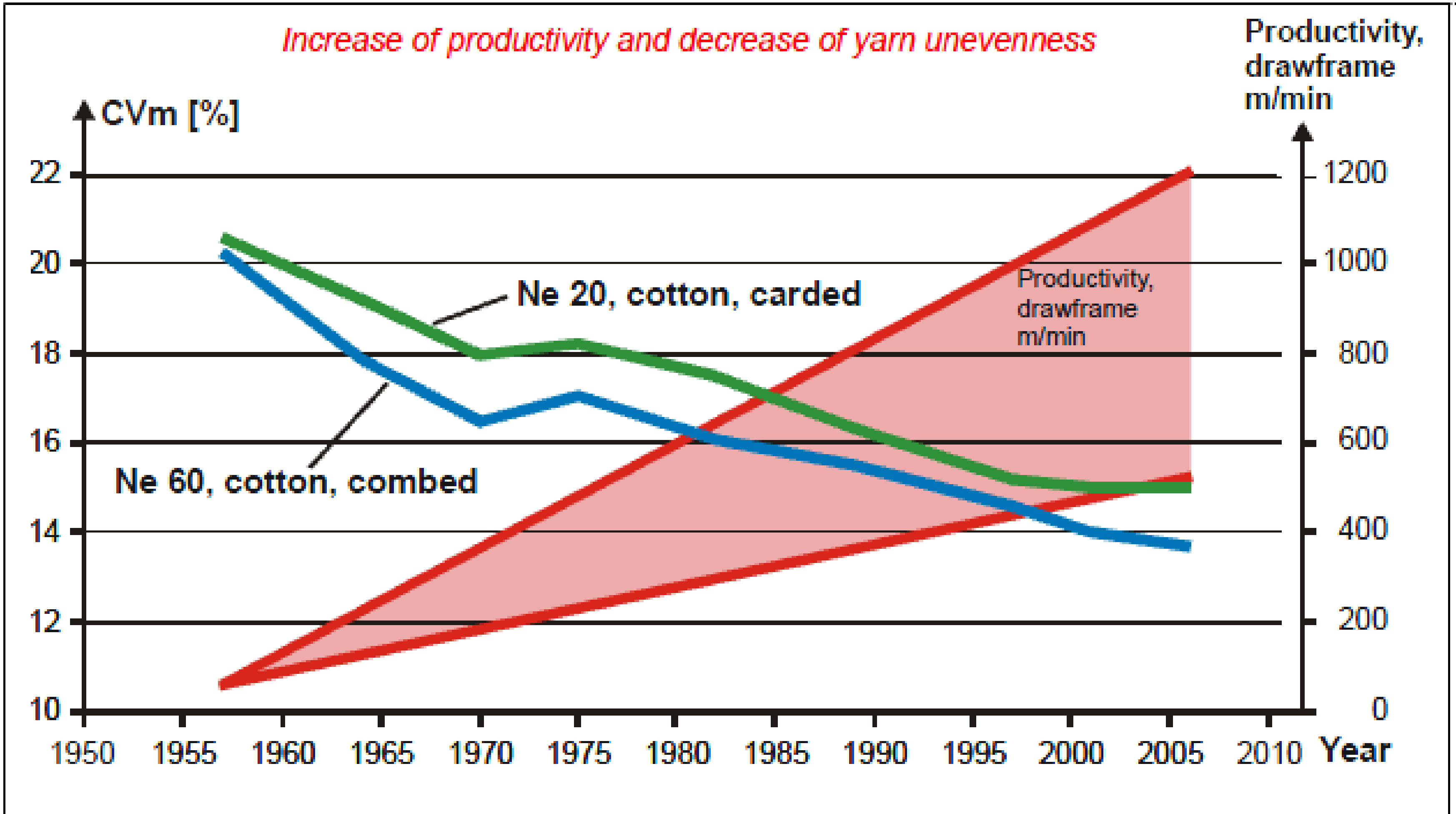
Very small fibre diameters (< 500 nm)

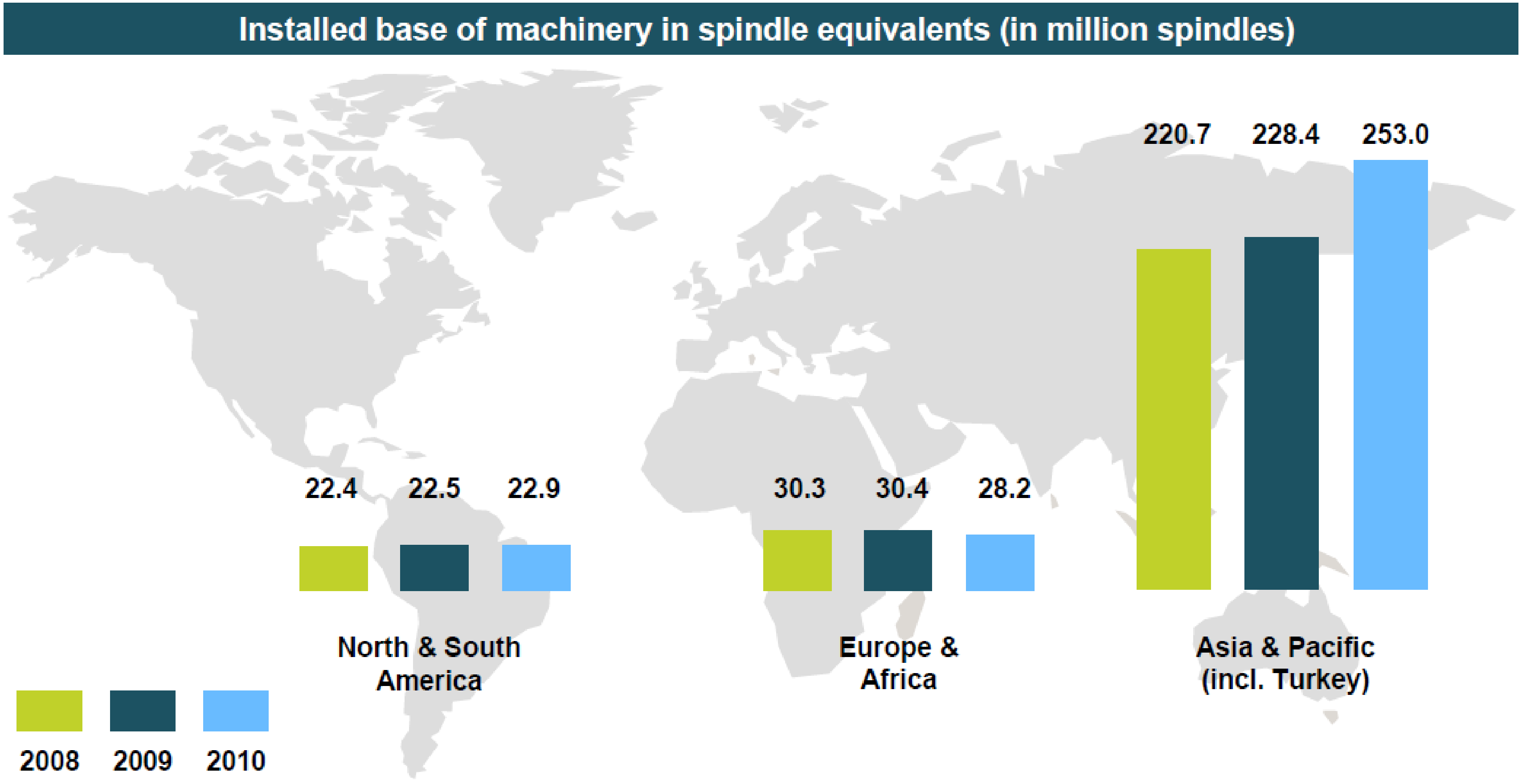
↓

High specific surface area

Small pore size

High porosity


Increase of productivity and decrease of yarn unevenness
CVm [%]
Productivity, drawframe m/min
22
20
18
16
14
12
10
1200
1000
800
600
400
200
0
Ne 20, cotton, carded
Ne 60, cotton, combed
Productivity, drawframe m/min
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year

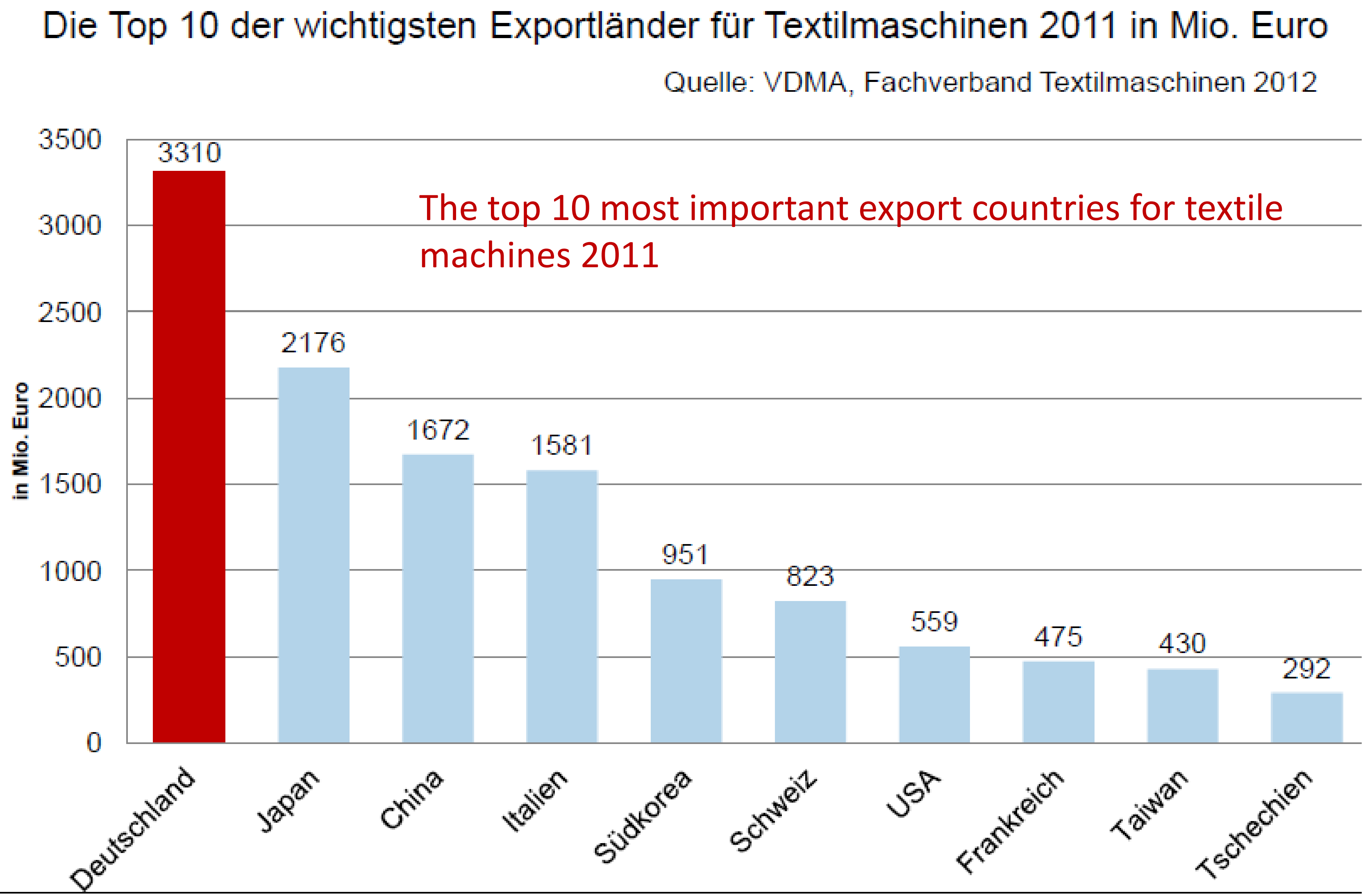


Source: ITMF – International Textile Machinery Shipment Statistics (2008) and estimation of Rieter for (2009 and 2010)

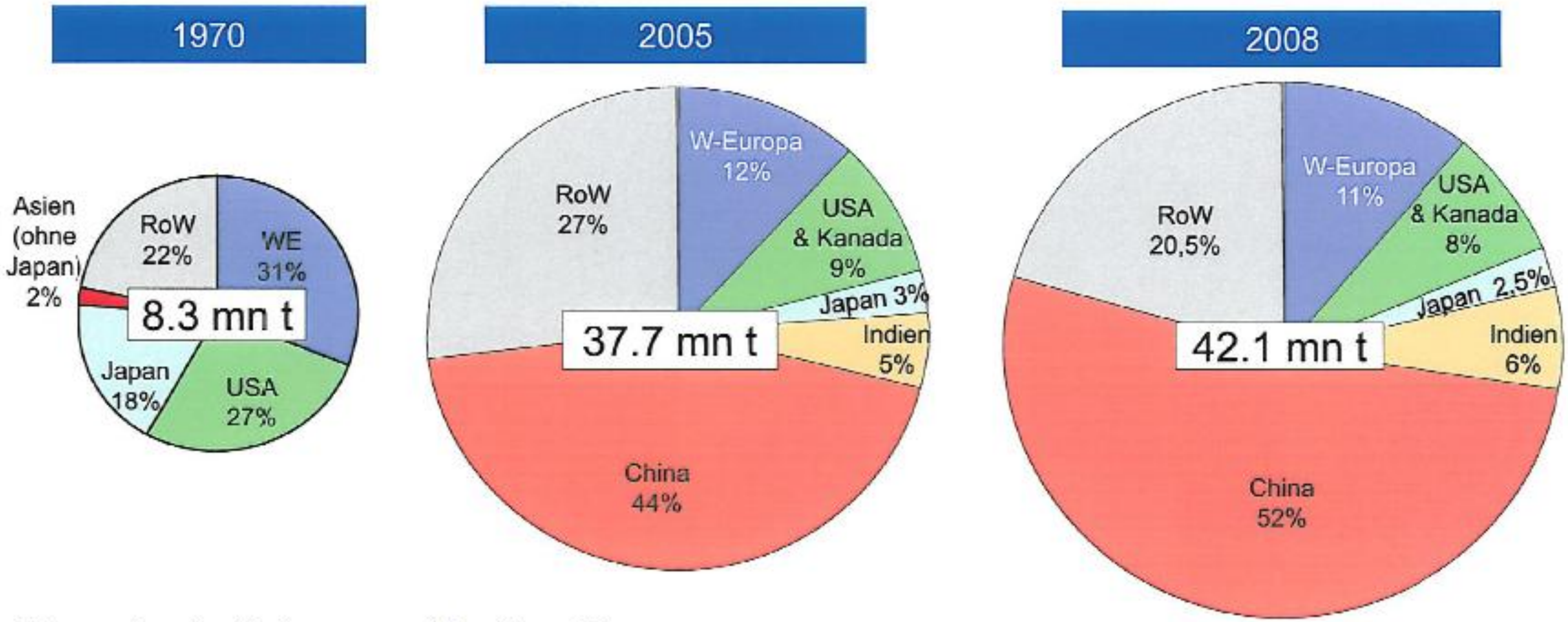
Successful examples

Quelle: Statista 2014, eigene Berechnungen

Successful examples

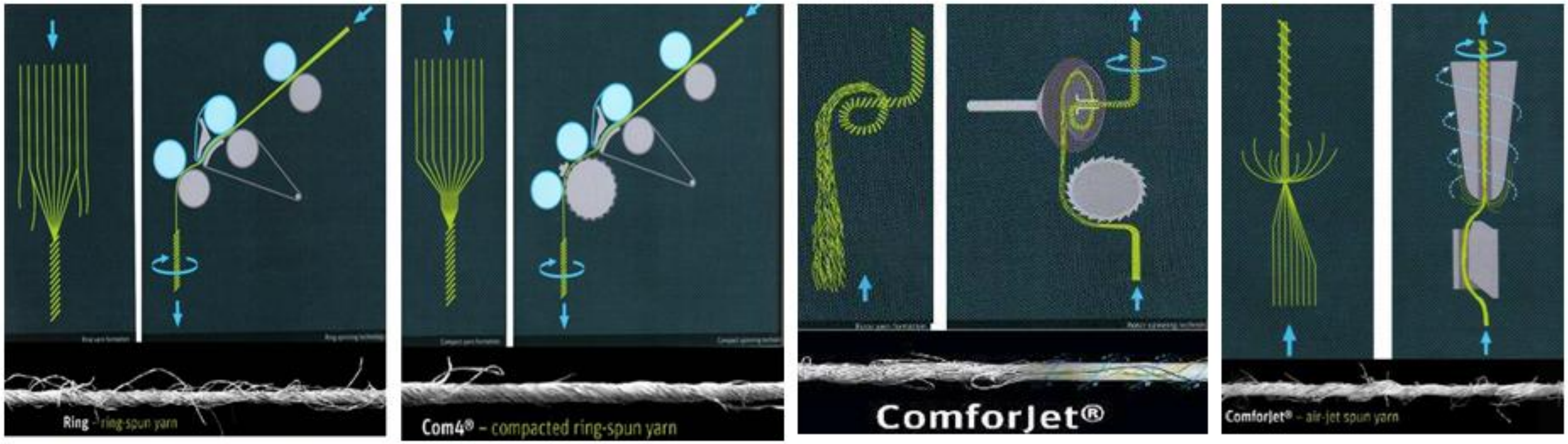


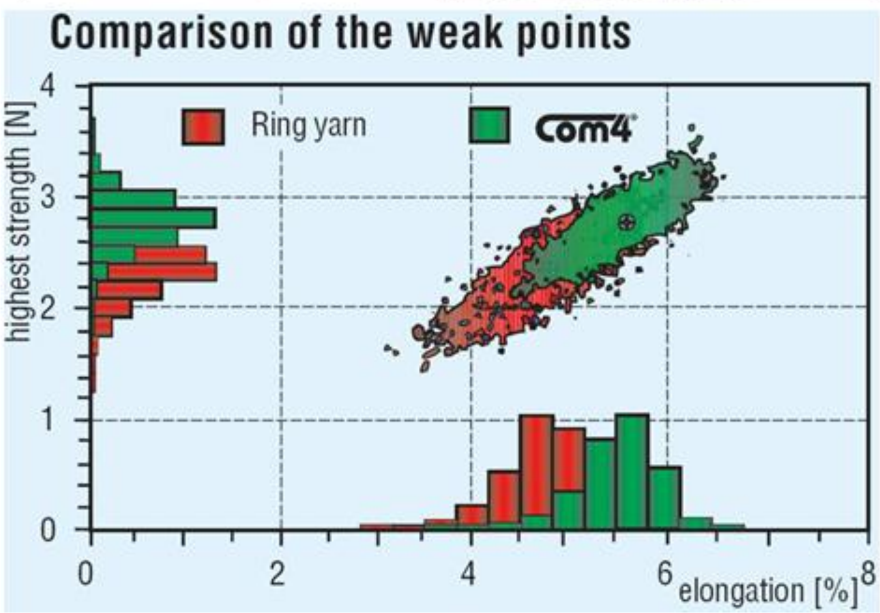
Vegyi szálgyártás mennyiségi növekedése és földrészenkénti, országonkénti megoszlása

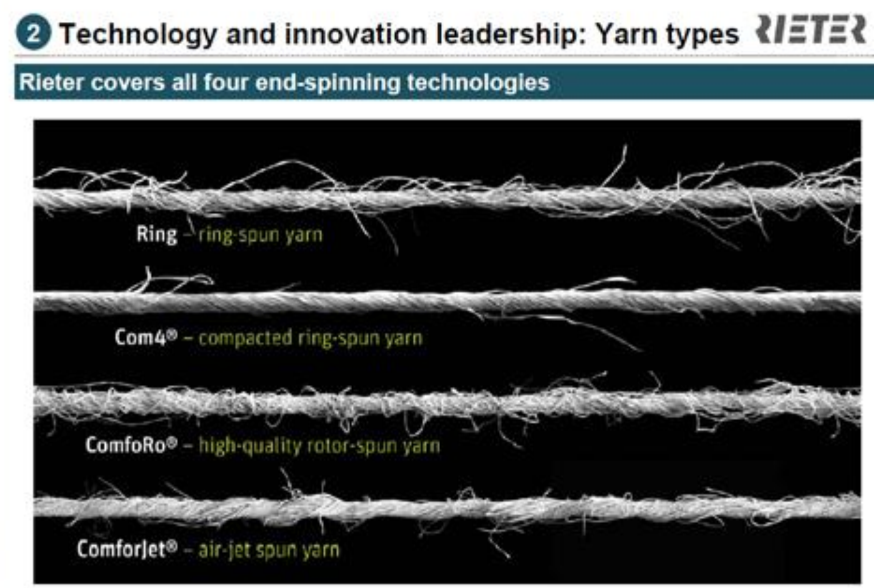


Filament-, vágott- és regenerált szál együtt

Different spinning technologies and their characteristics







Yarn clearing technology for all applications

Capacitive sensor

1960

USTER® *SPECTOMATIC*
The world's first electronic yarn clearer

1965

USTER® *AUTOMATIC*
The first yarn clearer for automatic winding machines

Optical sensor

1993

USTER® *PEYER P551*
The pioneer in optical clearing

1995

USTER® *PEYER 200F*
The first optical foreign fiber clearer

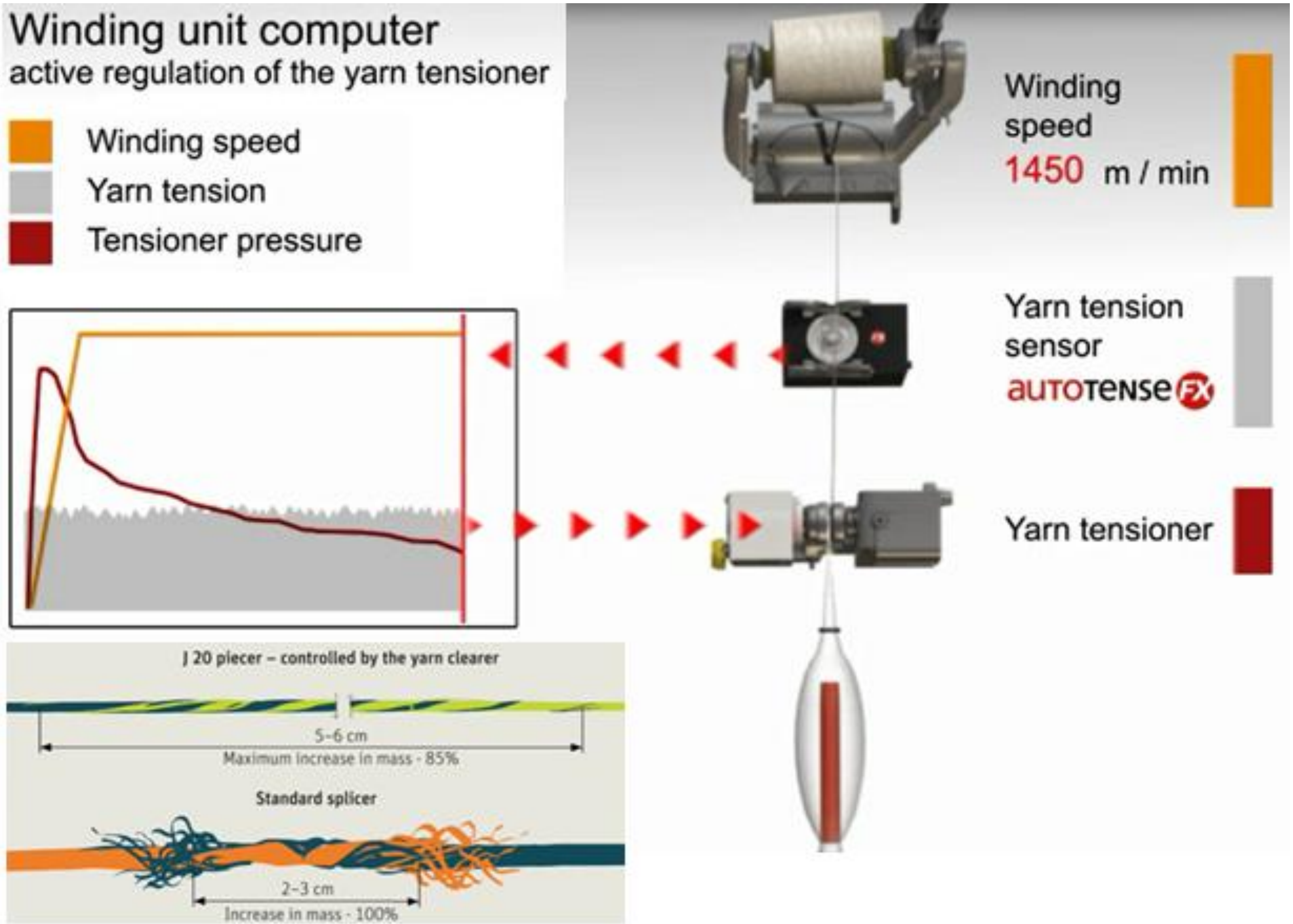
1999

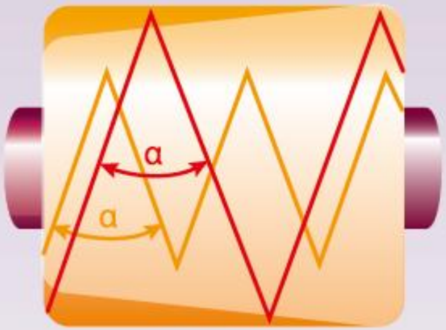
Uster® *QUANTUM 2*
Featuring optical and capacitive clearing technology

2010

USTER® *QUANTUM 3*
Smart yarn clearing

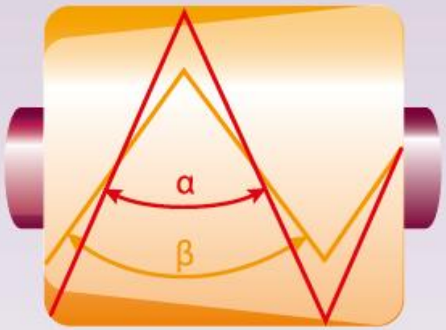
Winding technology





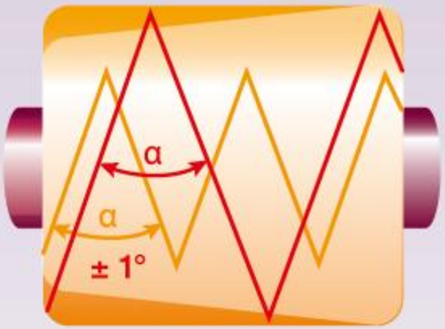
PreciFX:
Precise random wind

- Constant crossing angle
- Decreasing winding ratio with increasing diameter
- Stable package format
- No pattern zones
- No bulging package flanks
- Anti-latching
- Flexible adjustment of groove turns / crossing angle



PreciFX:
Precision winding

- Decreasing crossing angle with increasing diameter
- Constant winding ratio
- Defined constant yarn distance
- No pattern zones

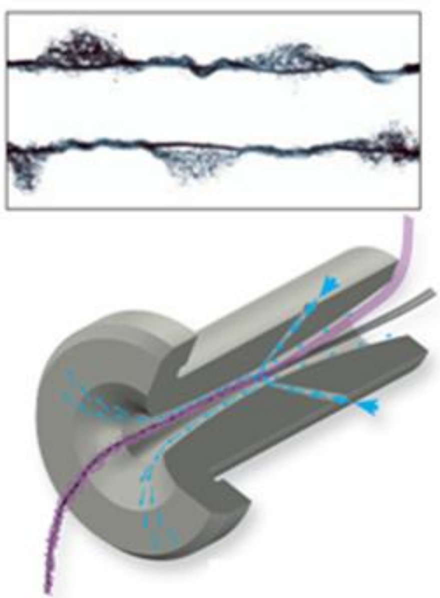


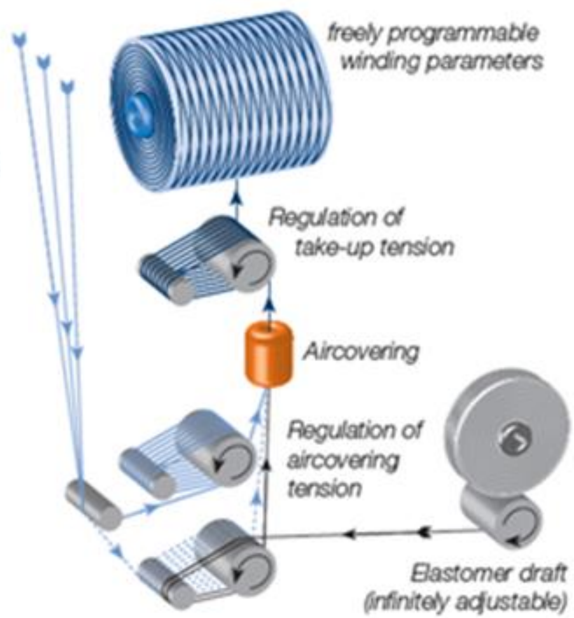
PreciFX:
Step-precision winding

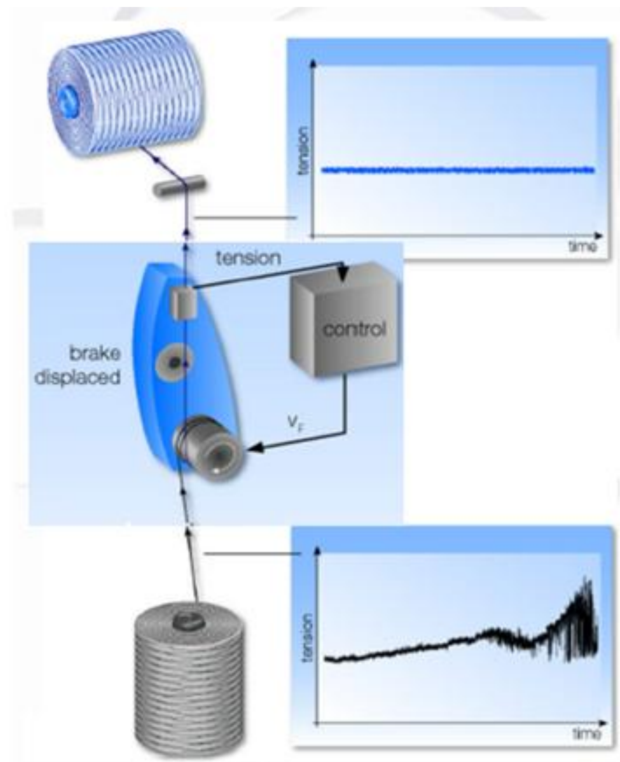
- Almost constant crossing angle
- Gradual constant winding ratio
- Defined yarn distance
- Stable package format
- Uniform density
- No pattern zones

Air covering/Intermingling/Interlacing

Air covering and intermingling – technologies for unique yarn creations







Interpretation of thread break

Yarn breaking frequency depend from the yarn load and tensile strength characteristics

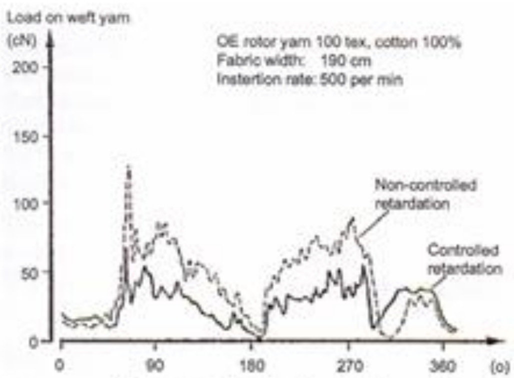


Diagram of the load applied on weft yarns within a complete cycle, rapier weaving machine

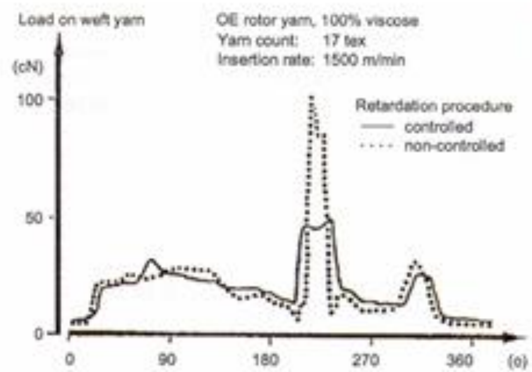
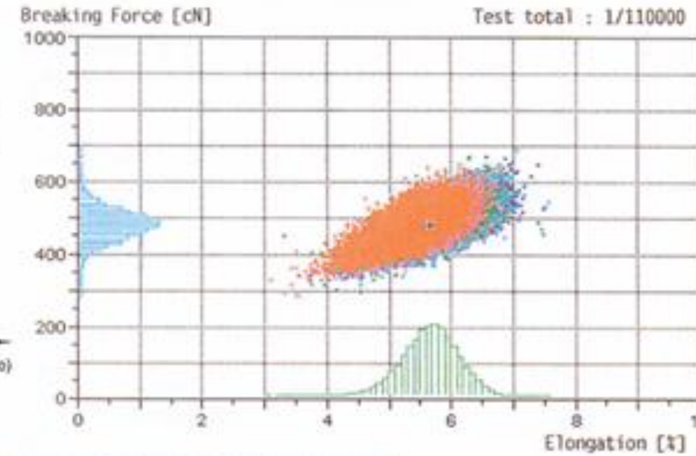


Diagram of the load applied on weft yarns, air-jet weaving machine



Variance

$$s^2 = \frac{\Sigma (x_i - \bar{x})^2}{n-1}$$

s^2 = variance of the sample

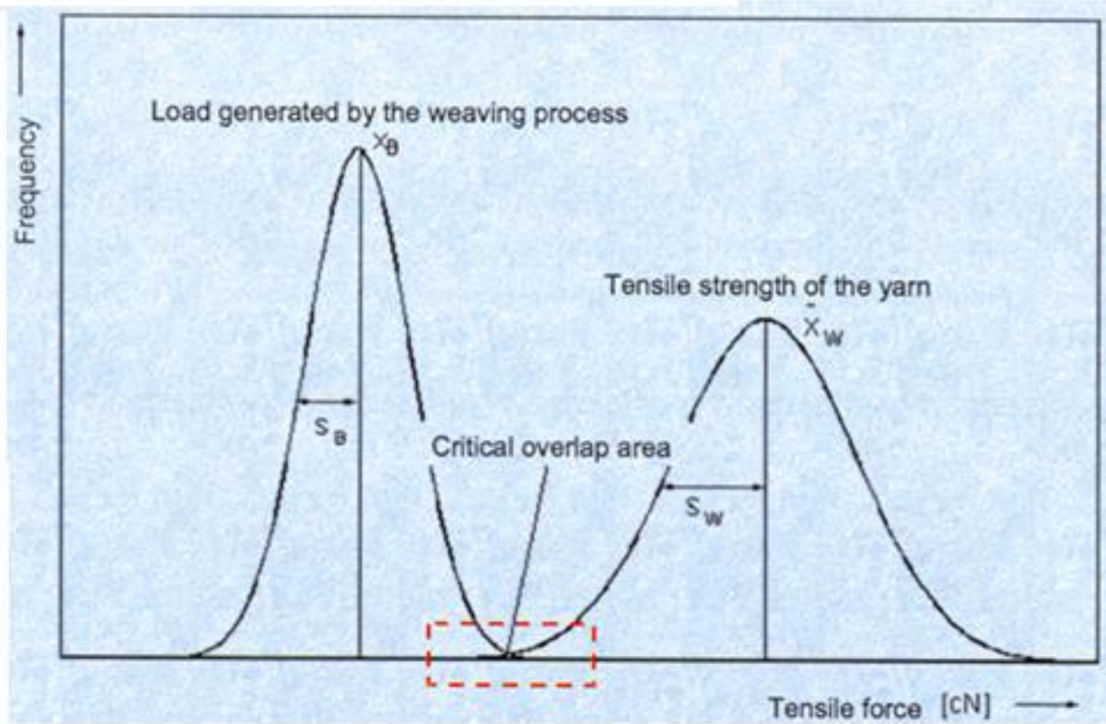
x_i = single value of the sample

$\bar{x}$ = mean value of the sample

n = number of single values of the sample

Standard deviation

$$s = \sqrt{s^2}$$



Coefficient of variations

$$CV = \frac{s}{\bar{x}}$$

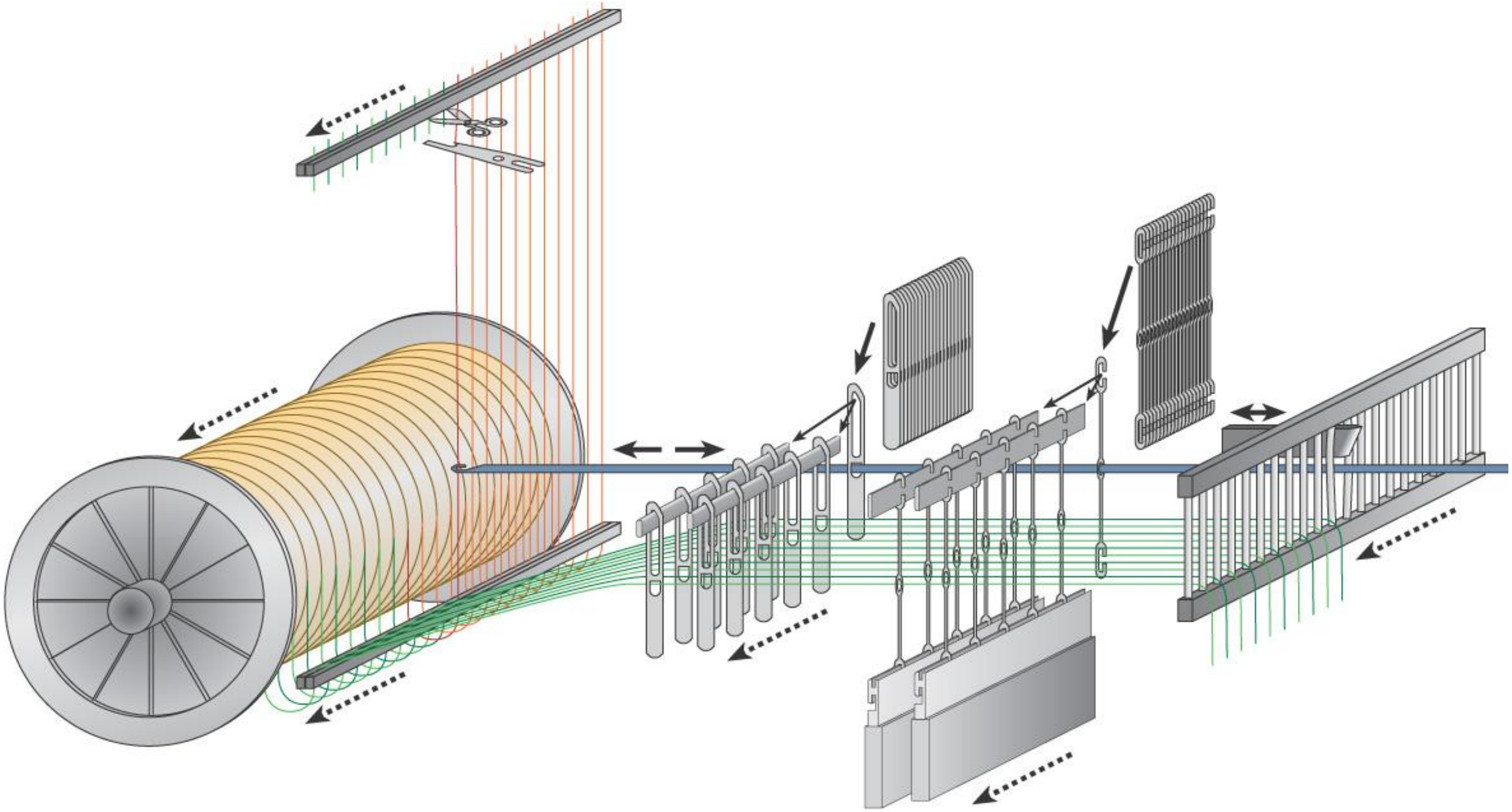
CV = coefficient of variation

S = standard deviation

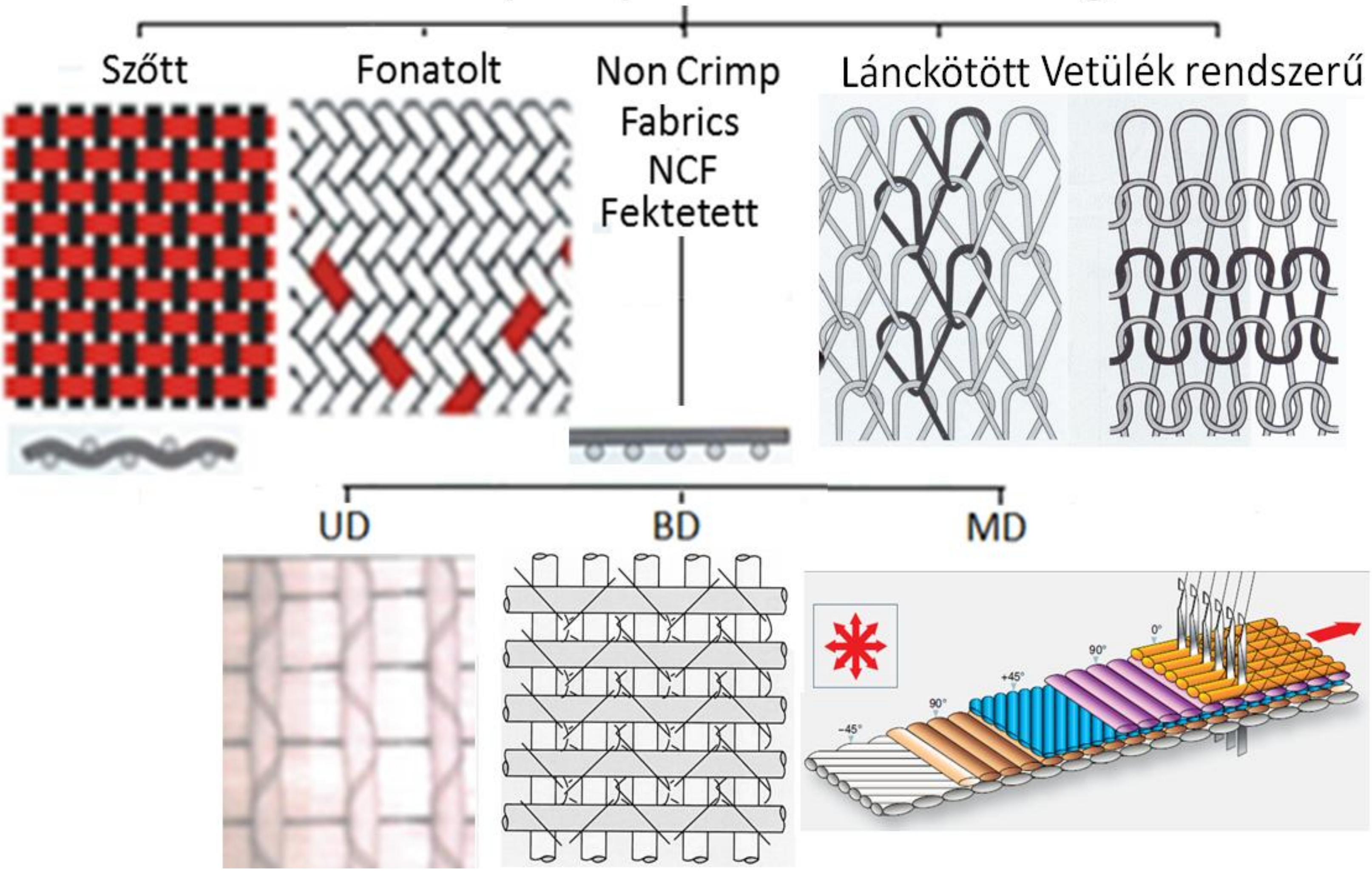
$\bar{x}$ = mean value

Karl Mayer AccuTense – Computer controlled hysteresis yarn tensioner for glasfibre, kevlar, carbon

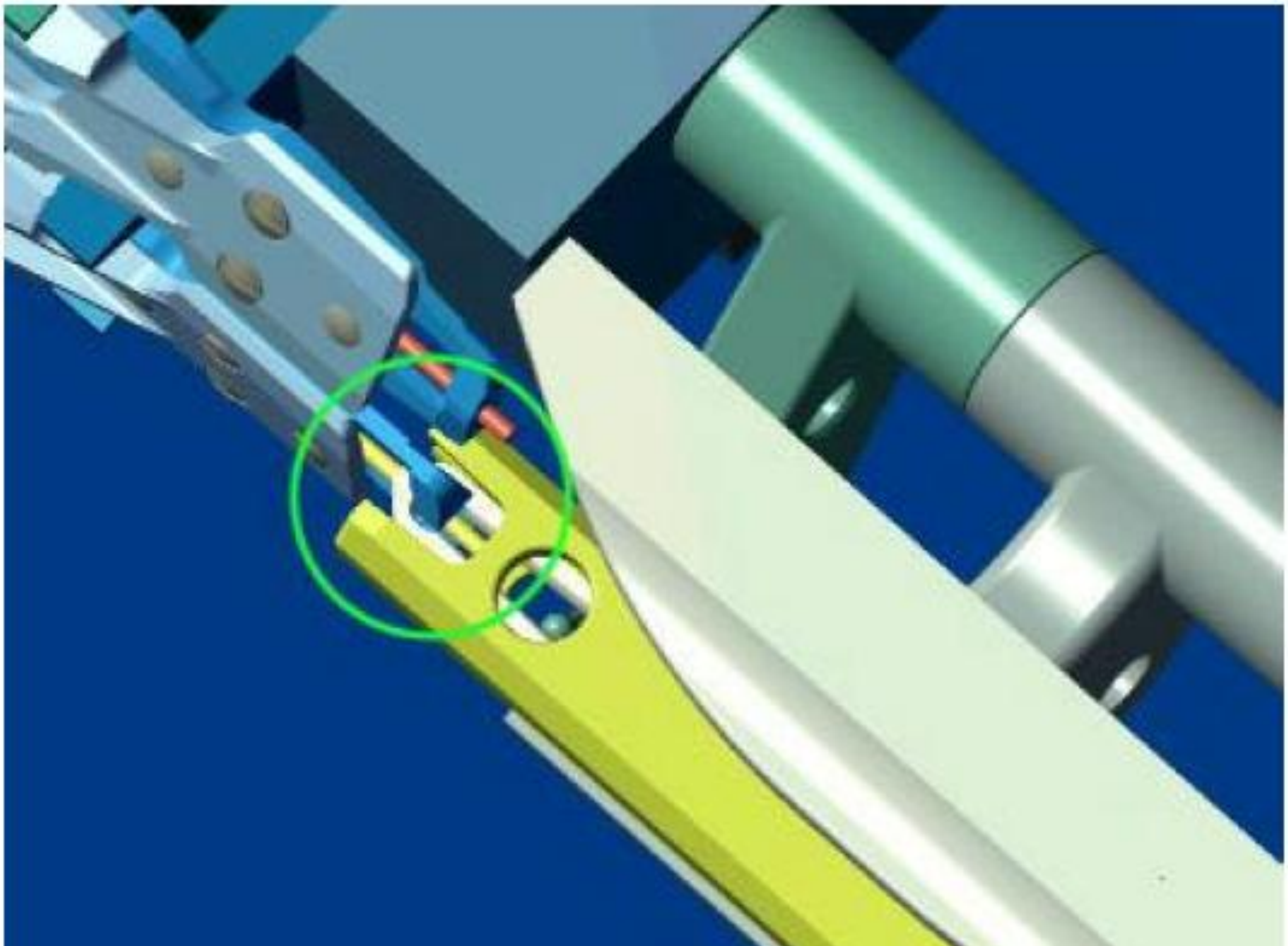
Automatic drawing-in – the principle



Fonalas lapképzési technológiák



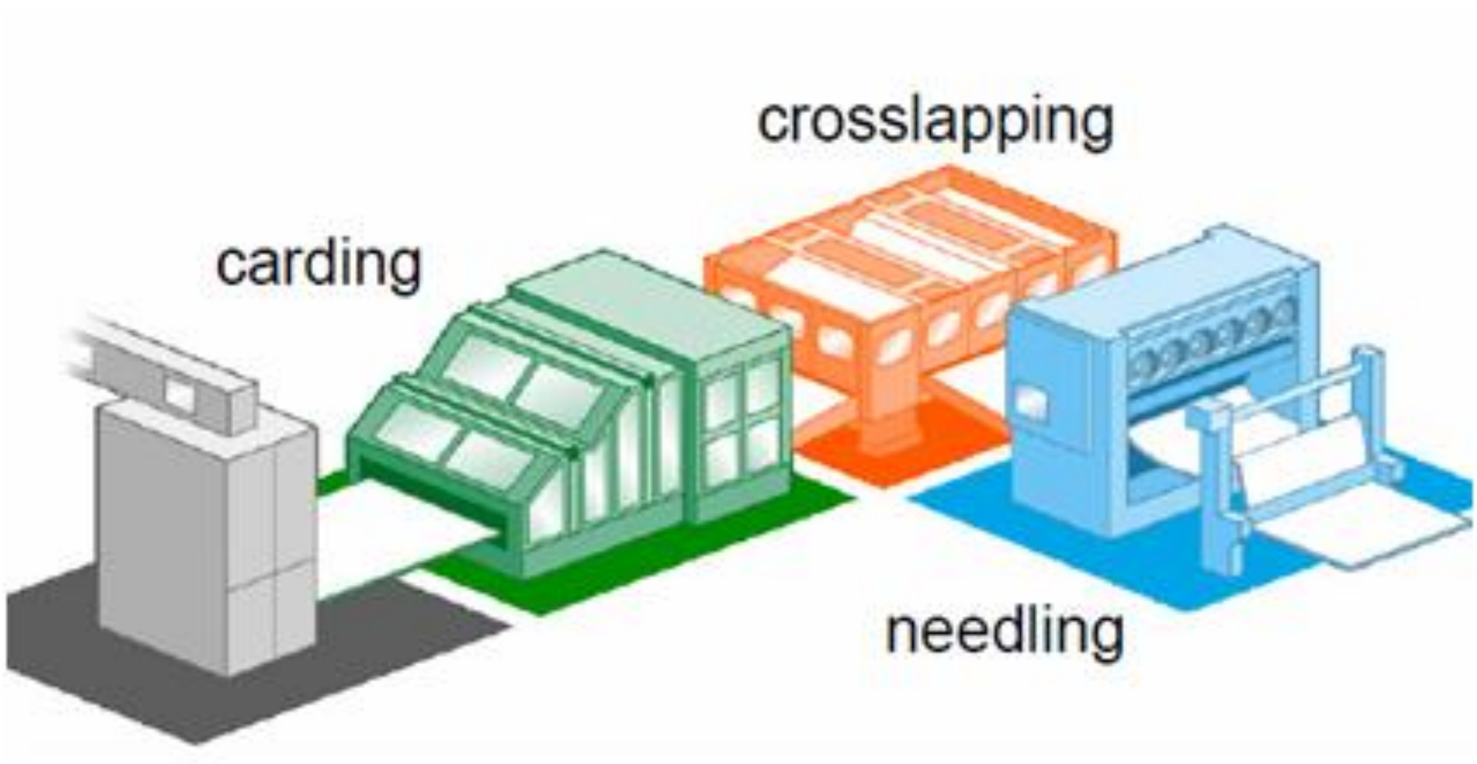
Now, the feeder gripper is opened by the feeder opener.




STÄUBLI
G6500

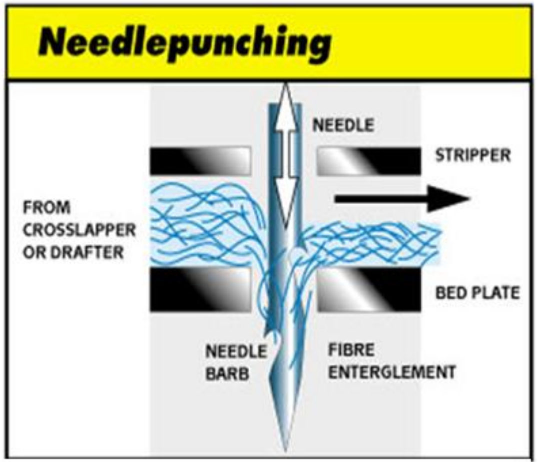

DEF
PARACADU
1000
RPM
0,0%
00:00:04
Produzione
Gestionale
Pannello controllo

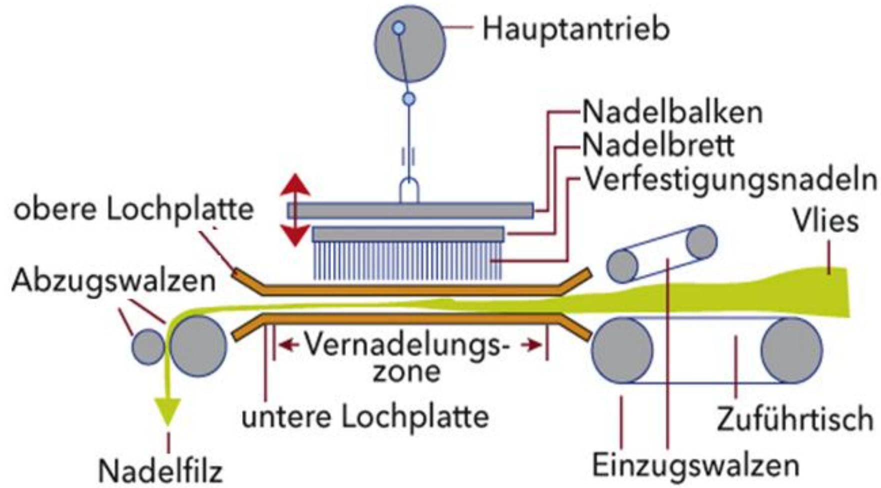
Dornier rapier weaving machine width Stäubli Unival Jacquard machine for 3D carbon fabrics

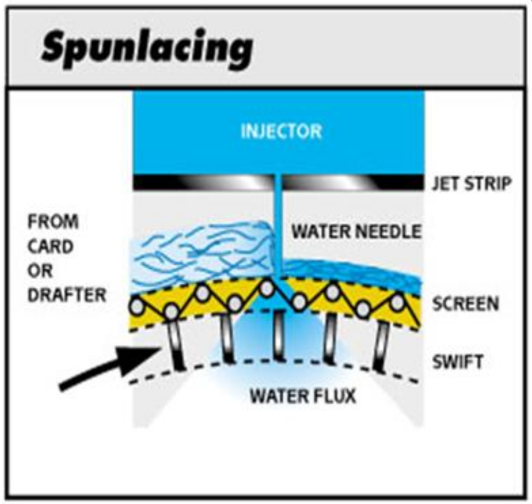

crosslapping
carding
needling

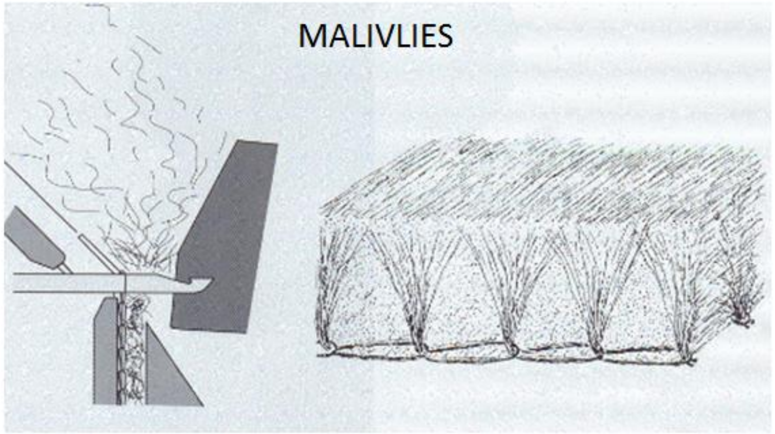
1. Mechanisch: Vernadeln

Principle of fiber enterglement

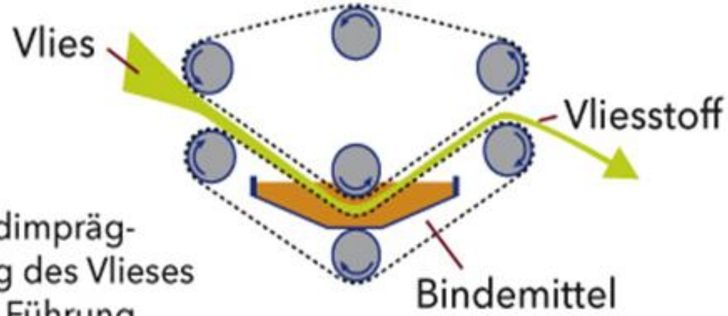






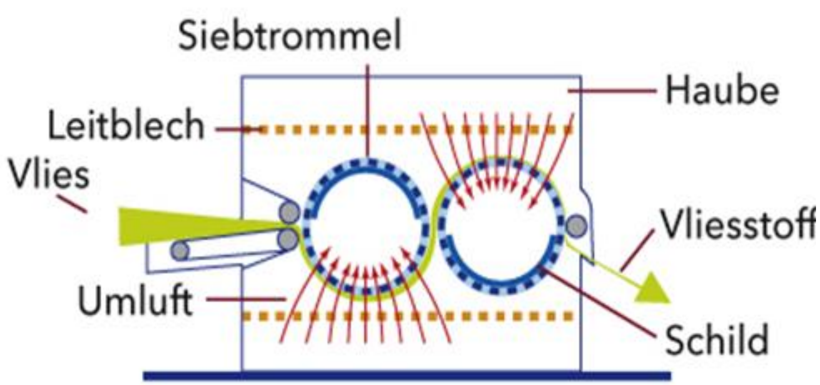


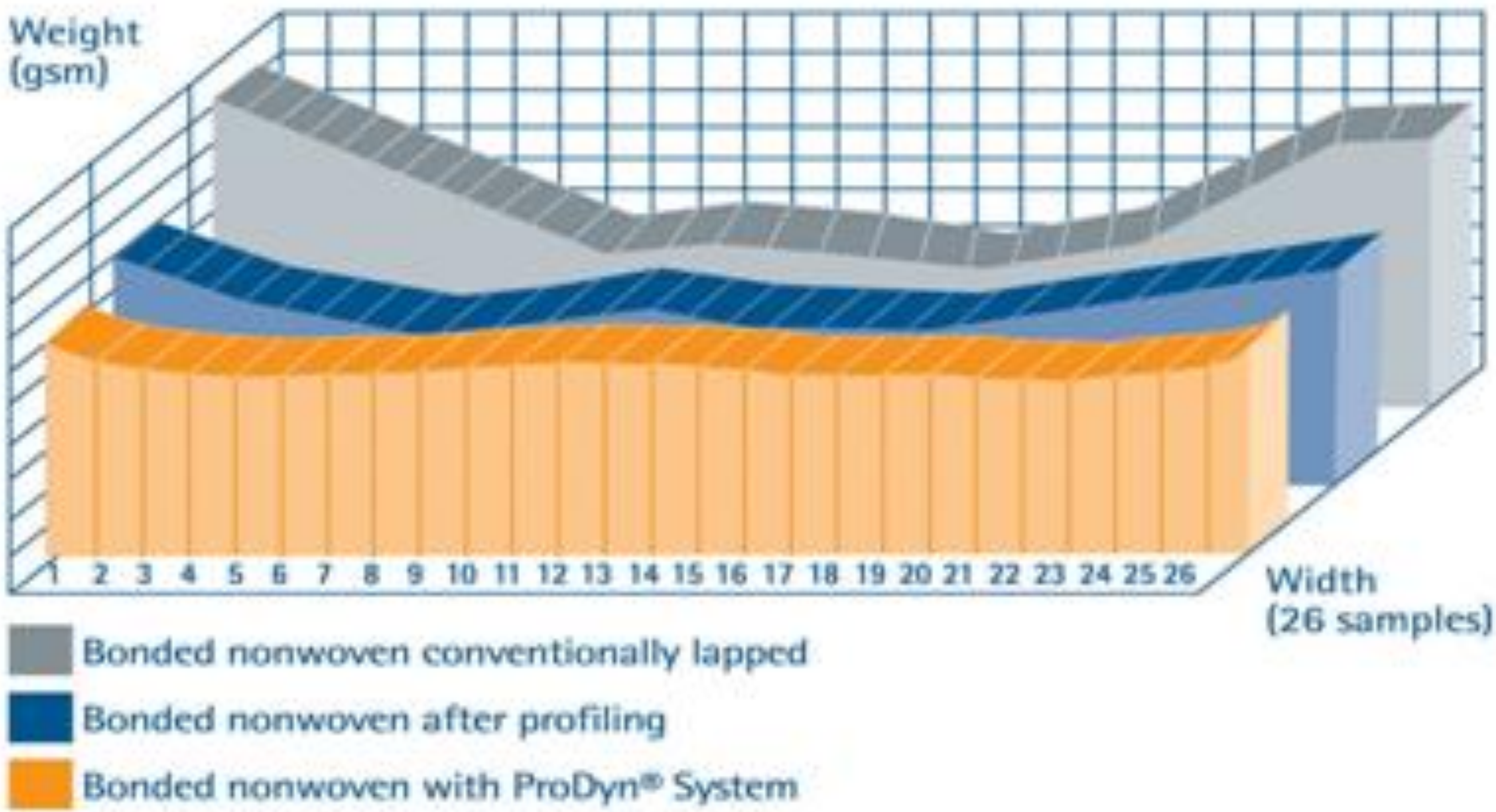
2. Chemisch: Bindemittel



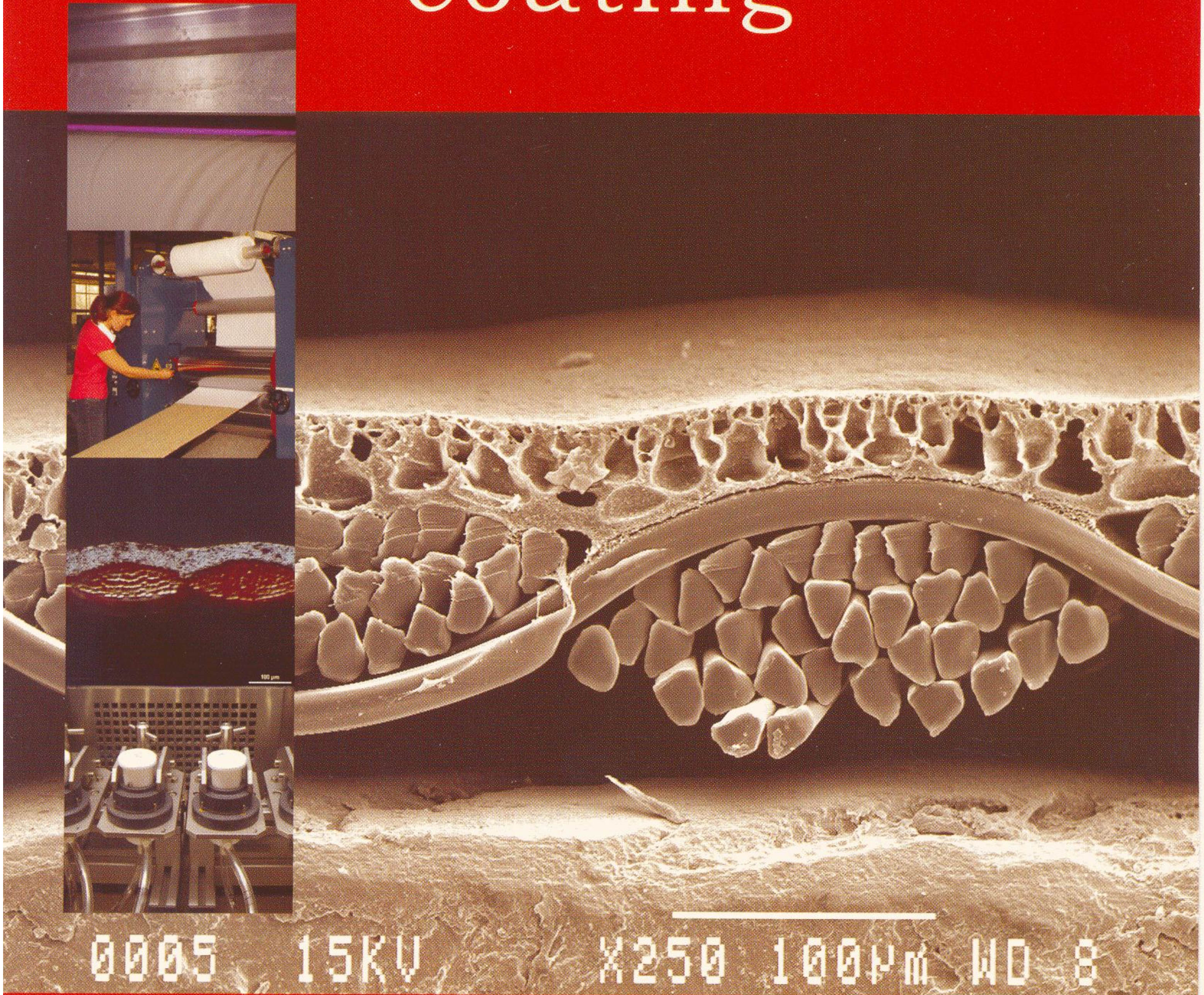
Vollbadimprägnierung des Vlieses mittels Führung durch Siebband

3. Thermisch: Verschweissen



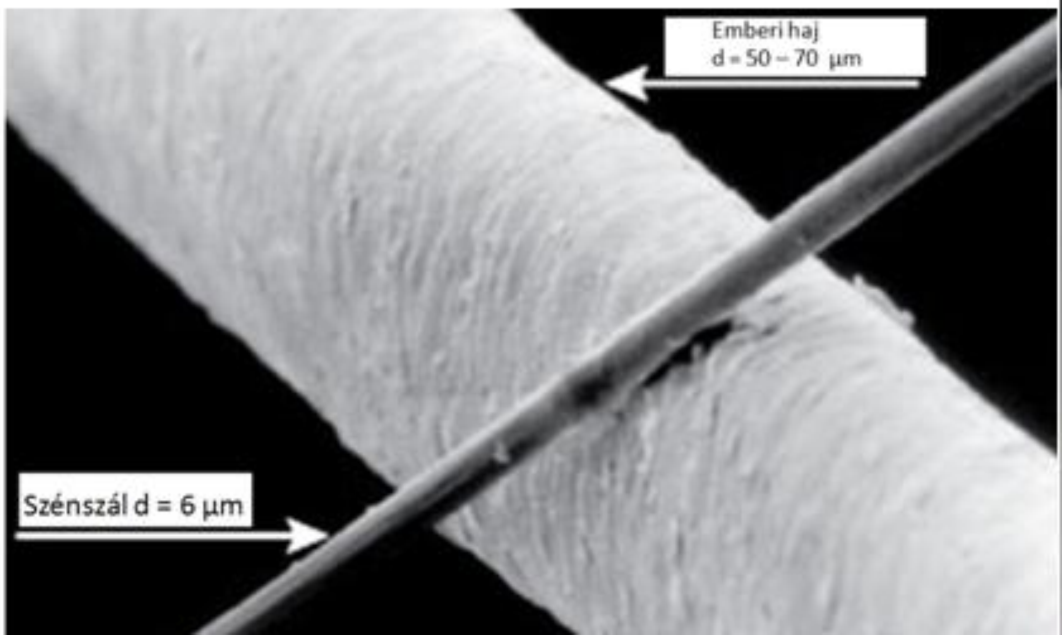

Weight (gsm)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Width (26 samples)
Bonded nonwoven conventionally lapped
Bonded nonwoven after profiling
Bonded nonwoven with ProDyn® System

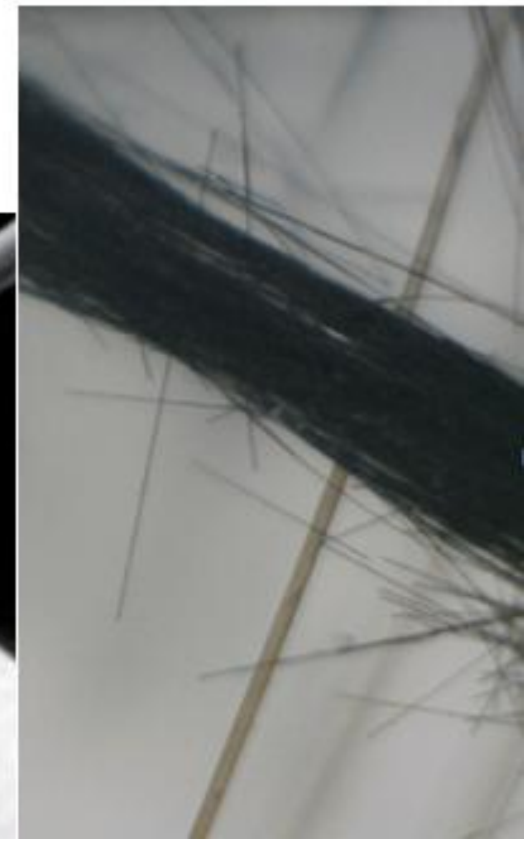
coating



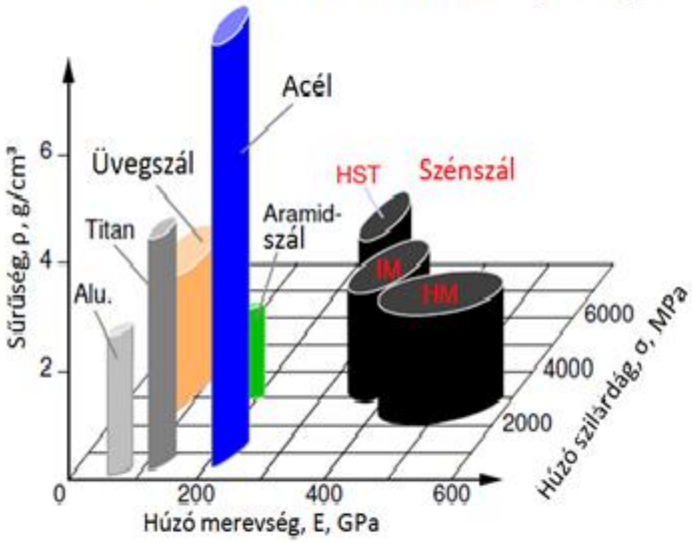
Szénszál főbb jellemzői

- Szénszál nagyon vékony (d= 5-7μm, ~0,7 dtex)
- Szénatom tartalma (>0,95%)
- Szénszélat nagyobbrészt kompoziterősítésre használják:
  CFRP- carbon fiber reinforced polymers →
  szénszál erősítésű polimer, C&C, C-SiC ....
- Szénszálakat felületkezelés után sodratlan kábelként (tow) keresztcsévélik, 1000 (1k) filamentenként jelölik:
  - Kis kábel: 1k, 3k, 6k, 12k, 24k
  - Nagy kábel: 48k, 50k, 60k ...

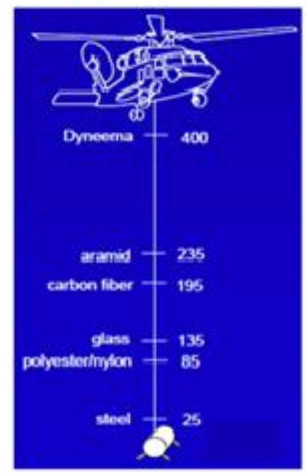




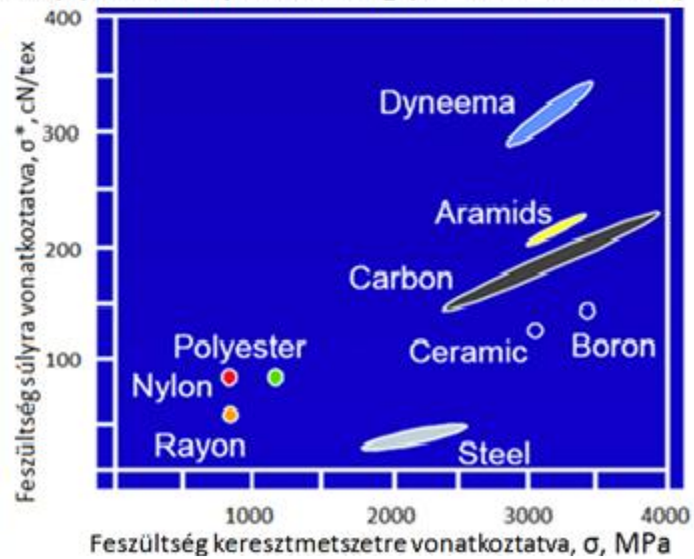
Erősítő szálak és fémek mechanikai tulajdonságai



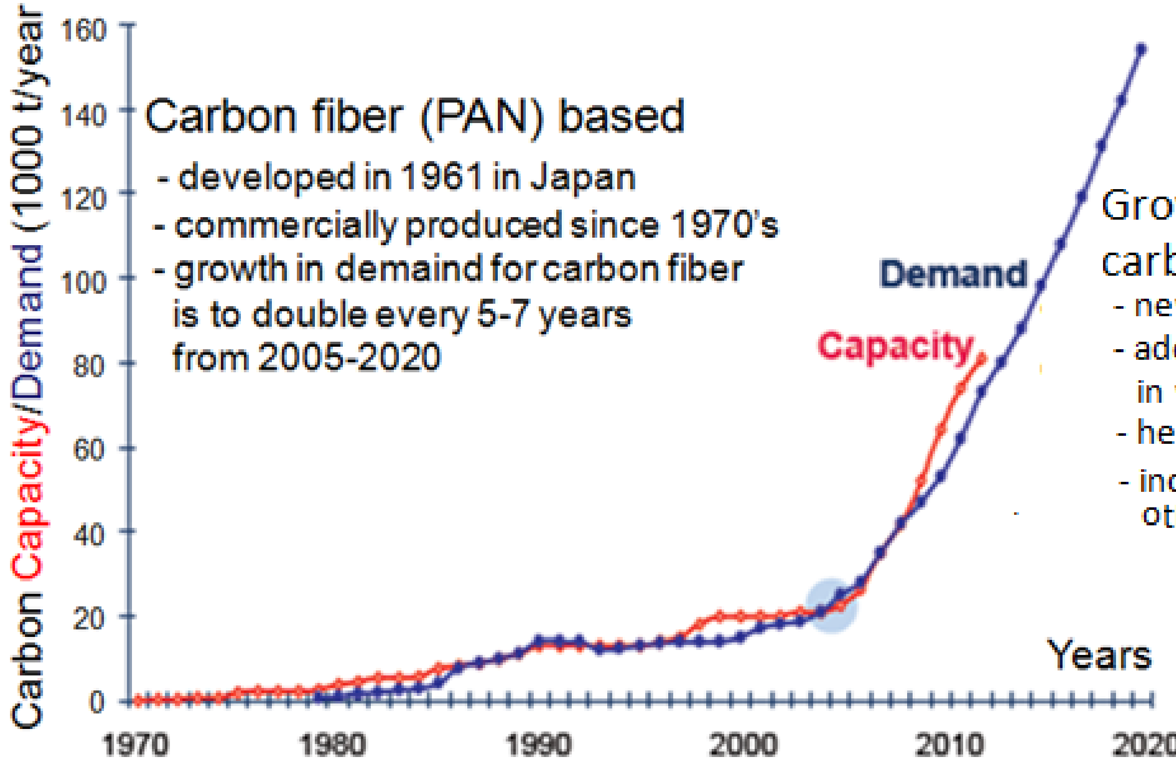
Különböző szálak keresztmetszetre (σ, Pa) és súlyra vonatkoztatott (specifikus) szilárdság (σ*, km→cN/tex)



Szakító hossz km→cN/tex
(Súlyra vonatkoztatott szilárdság)



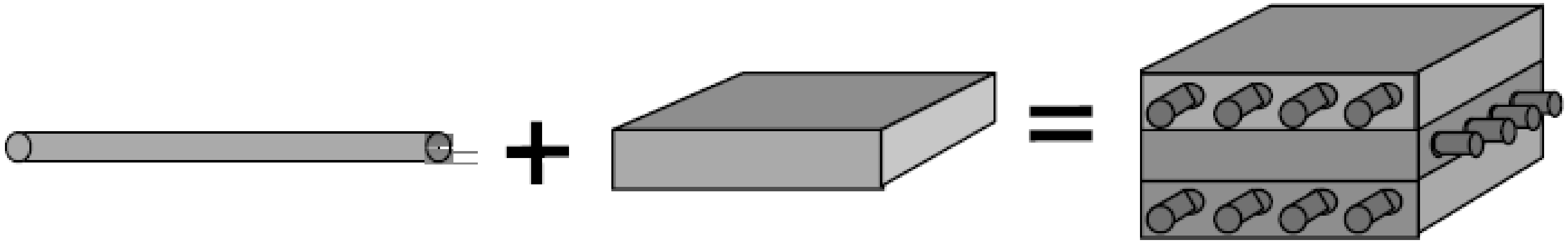
What is Carbon Fiber?



Growth in demand for carbon fiber accelerated:

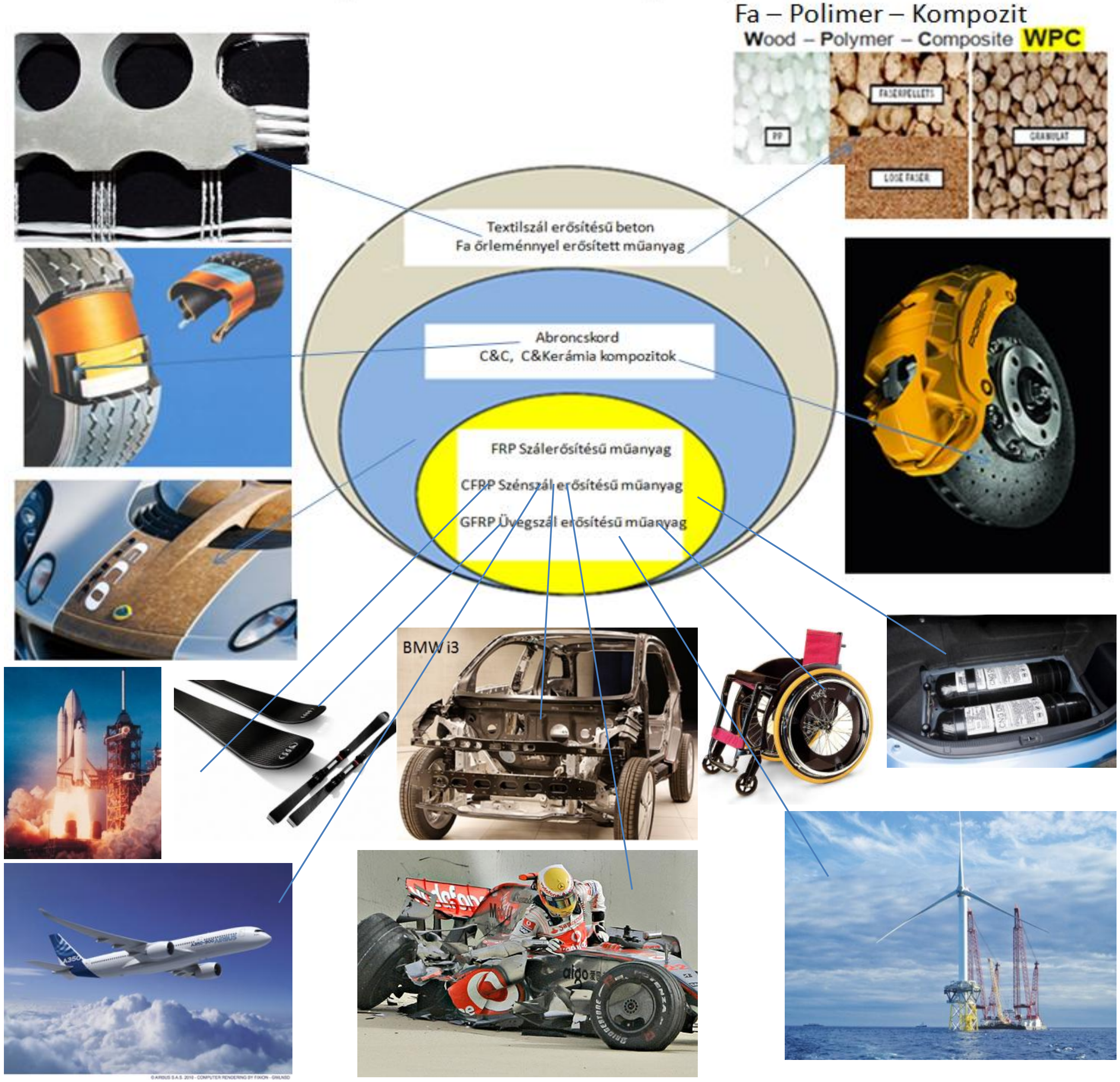
- new aircraft programs
- adoption of carbon fiber in wind blades
- heightenend interest in automotive
- industrie, infrastuctore and other new applications

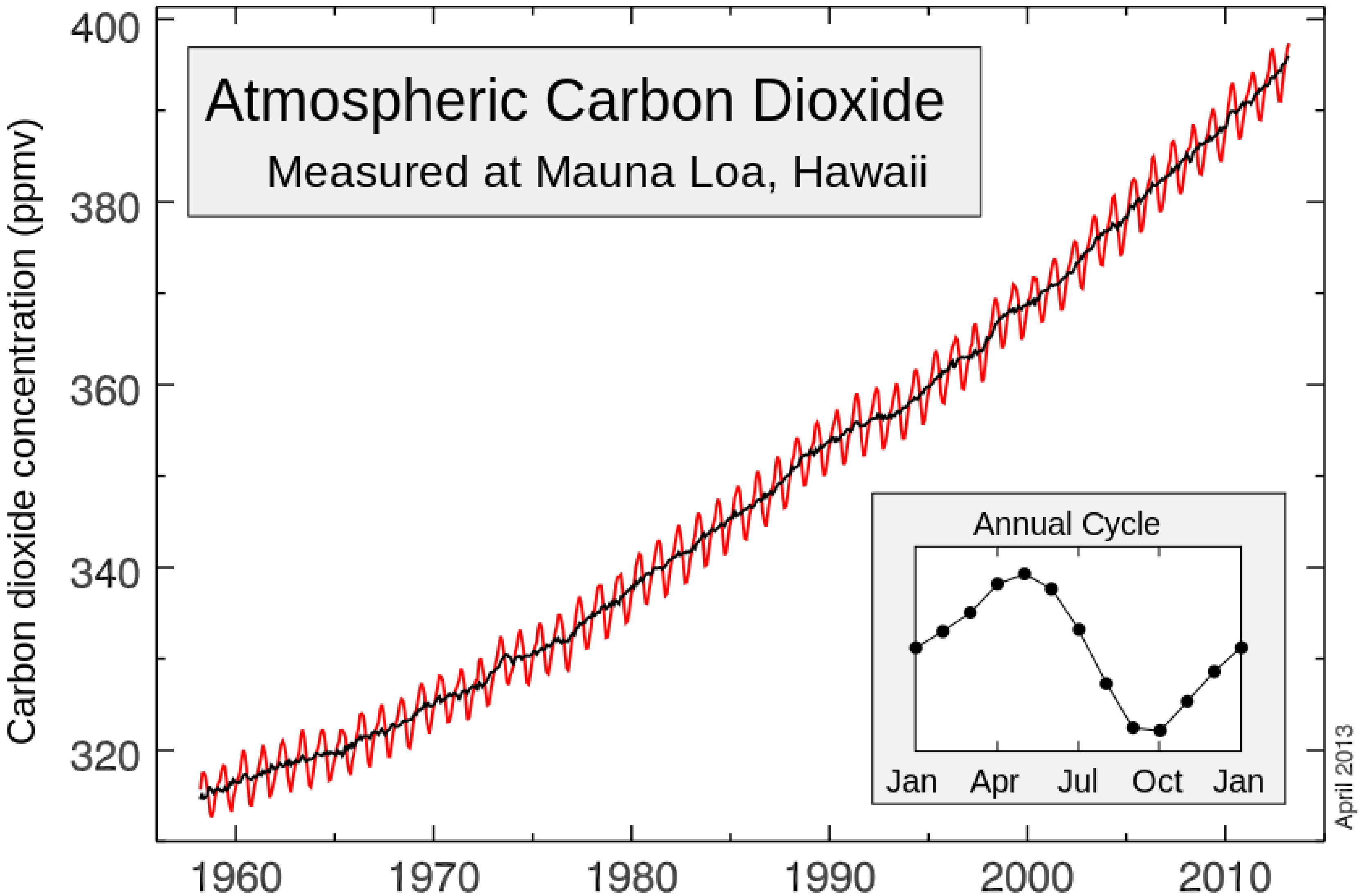
Composition of Composites



Fiber/Filament Reinforcement	Matrix	Composite
• High strength	• Good shear properties	• High strength
• High stiffness	• Low density	• High stiffness
• Low density		• Good shear properties
		• Low density

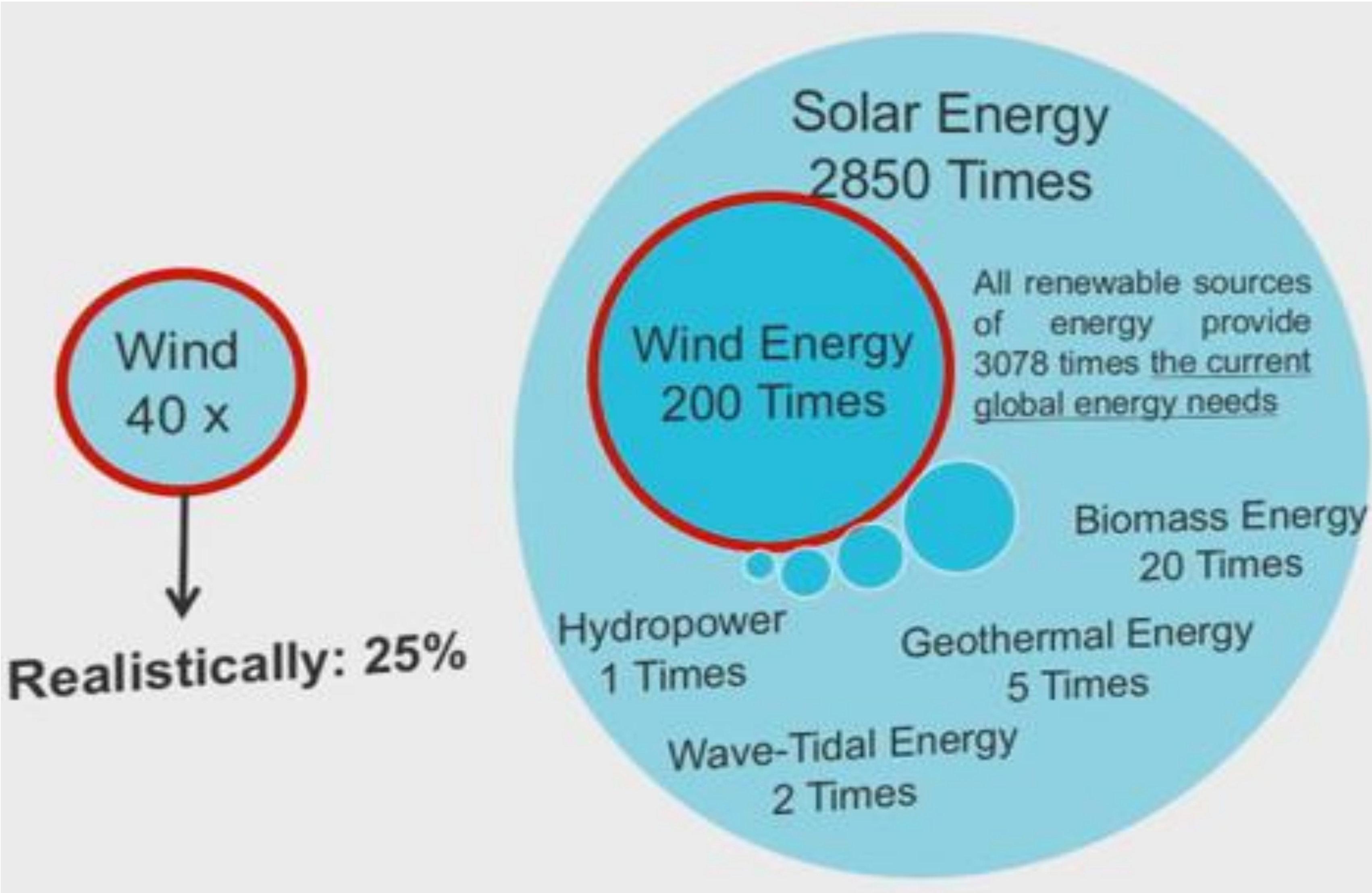
Kompozitok főbb csoportjai



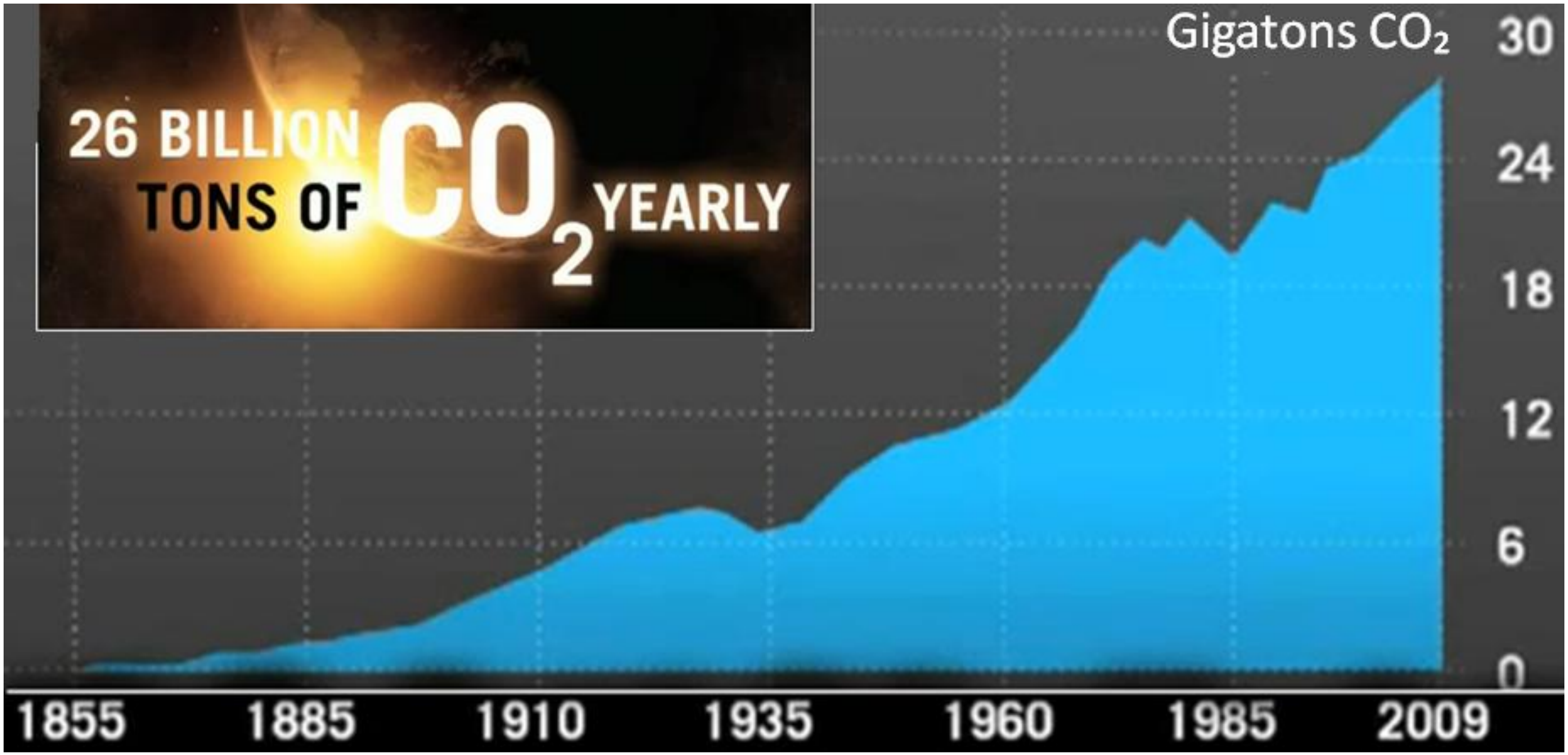

Atmospheric Carbon Dioxide
Measured at Mauna Loa, Hawaii
Carbon dioxide concentration (ppmv)
400
380
360
340
320
1960
1970
1980
1990
2000
2010
Annual Cycle
Jan
Apr
Jul
Oct
Jan
April 2013

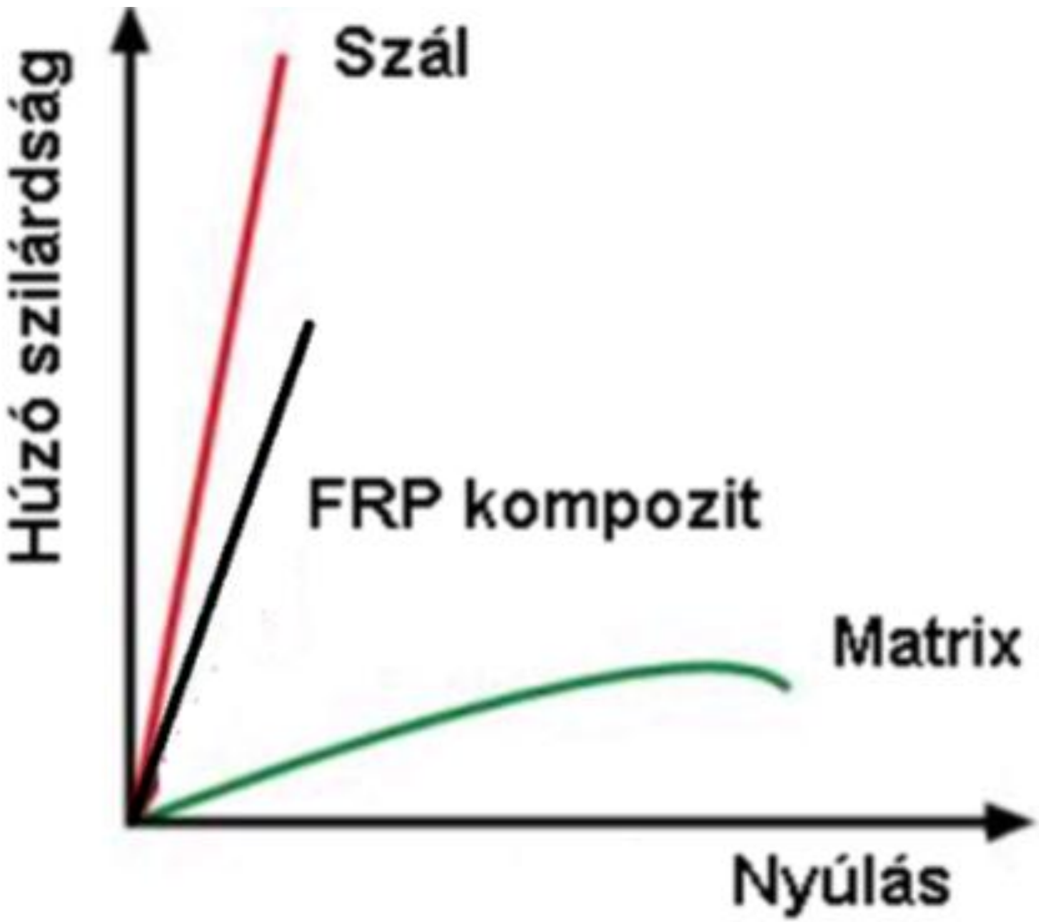
GREENHOUSE GAS (GHG) REDUCTION COMMITMENTS*

The wind energy resource



Global Carbon Emissions from Energy Production

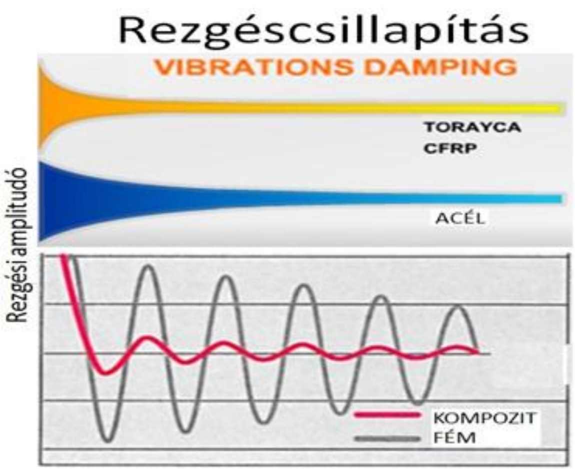




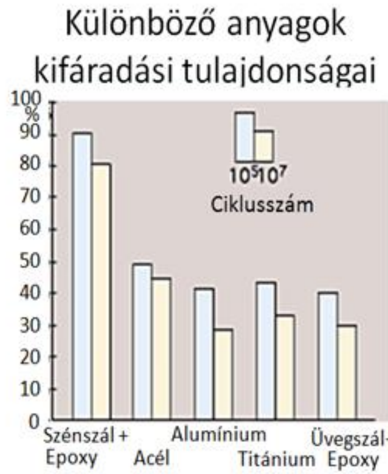
Kompozit tulajdonságait meghatározza:

- szál tulajdonságai,
- matrix tulajdonságai,
- szál és matrix aránya a kompozitban,
- szál geometriája és irányítottsága a kompozitban

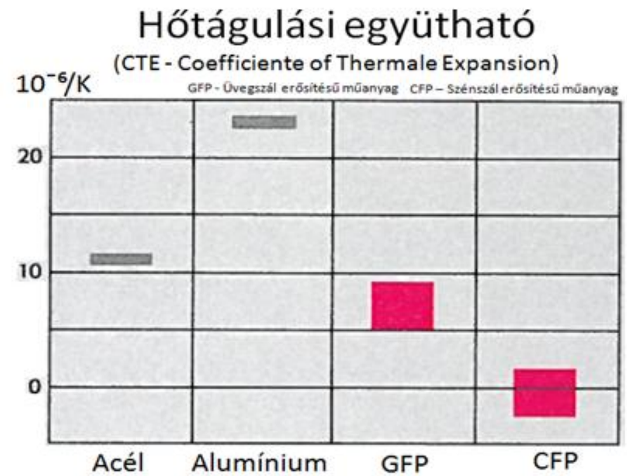
CFRP csillapítási, kifáradási, hőtágulási tulajdonságainak összehasonlítása



a.,

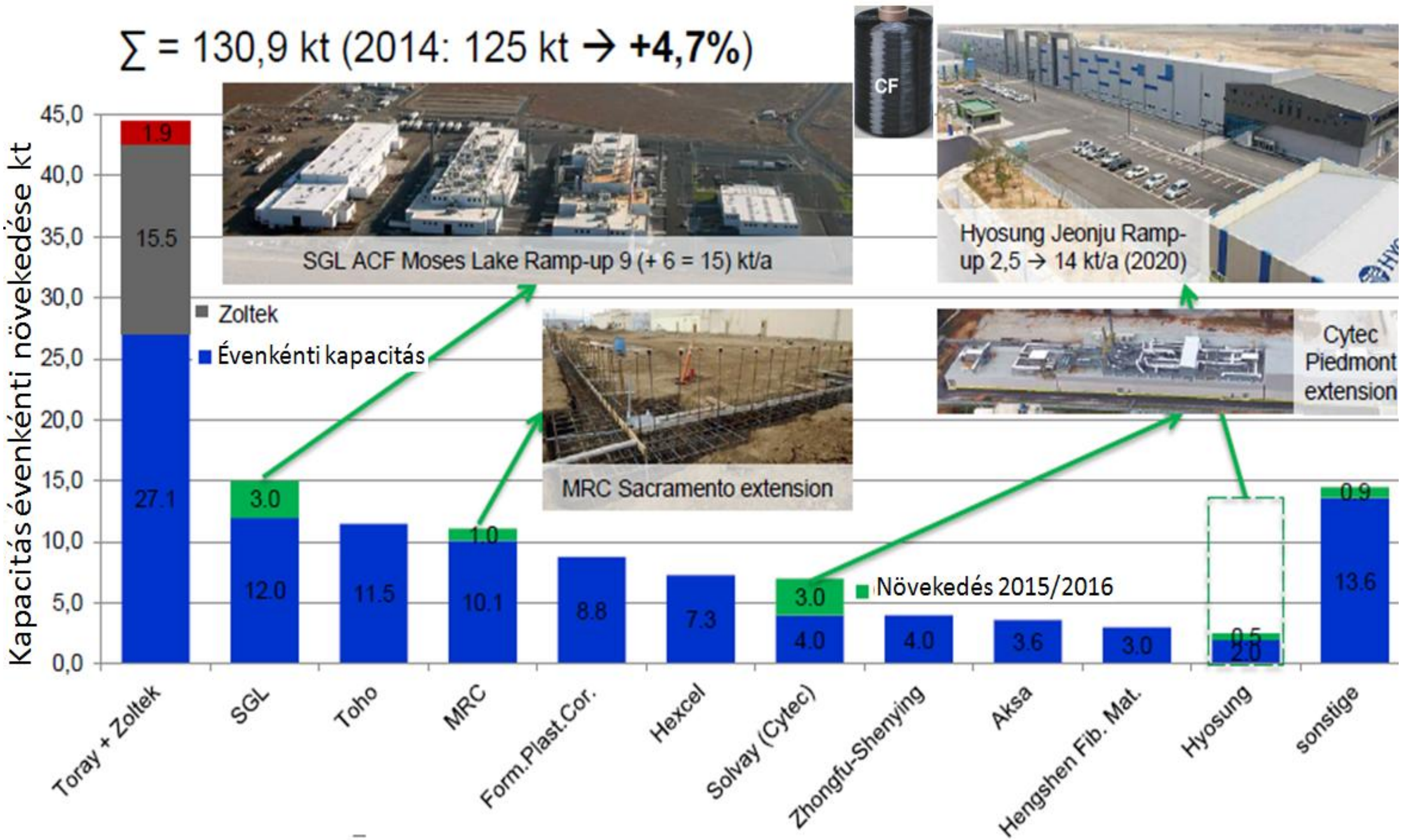


b.,

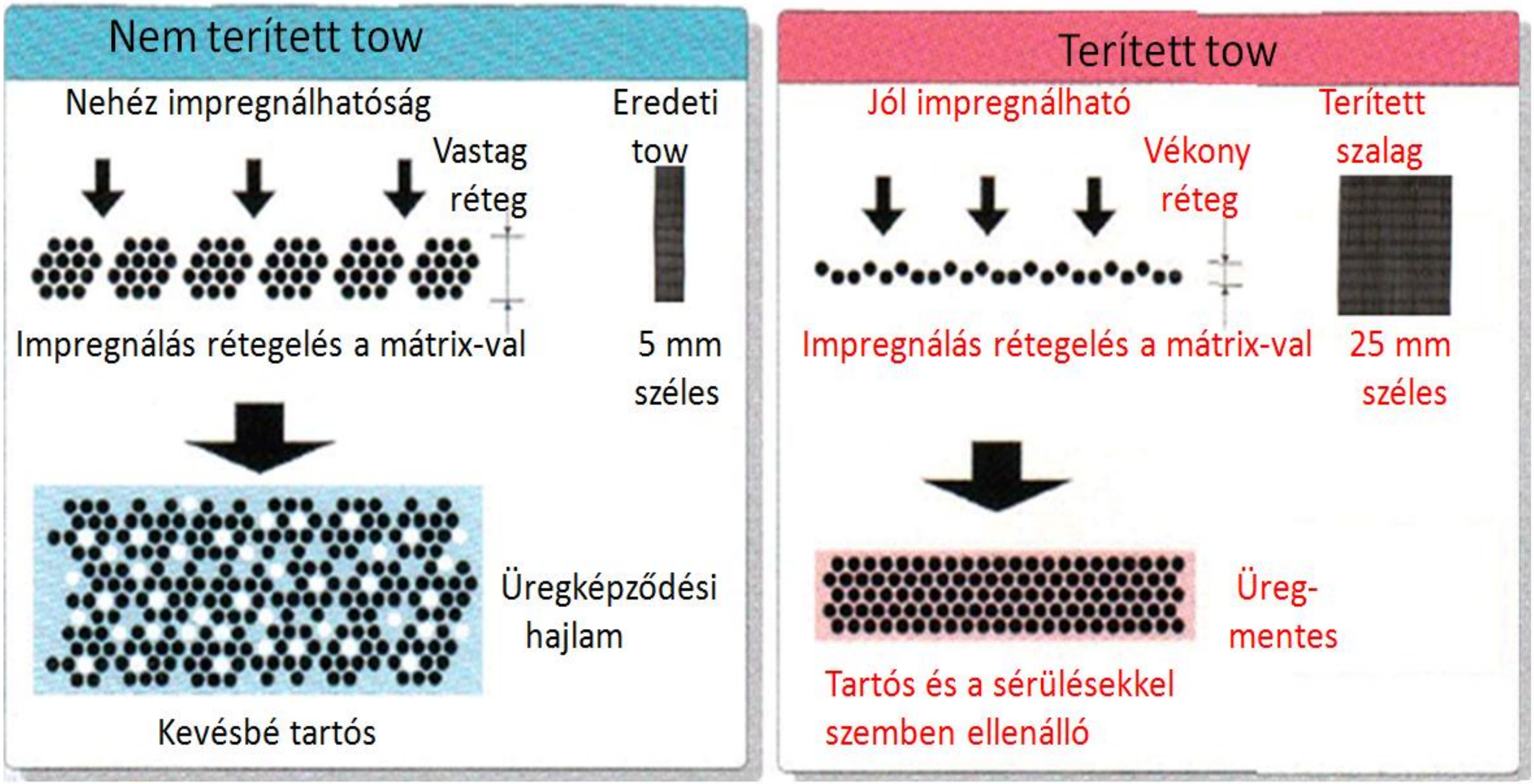


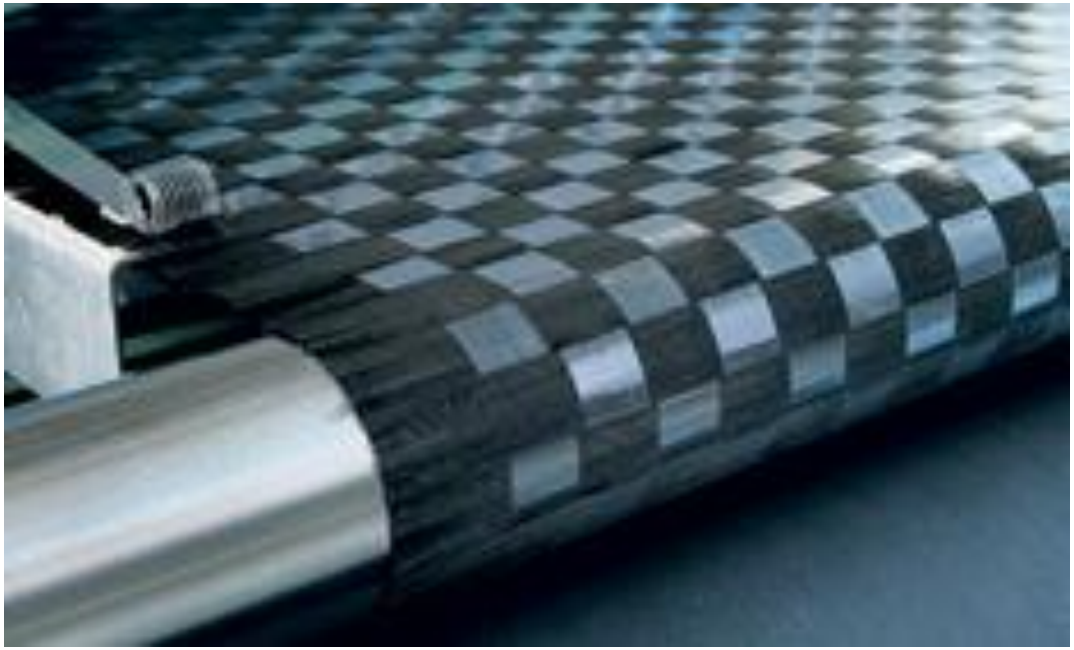
c.,

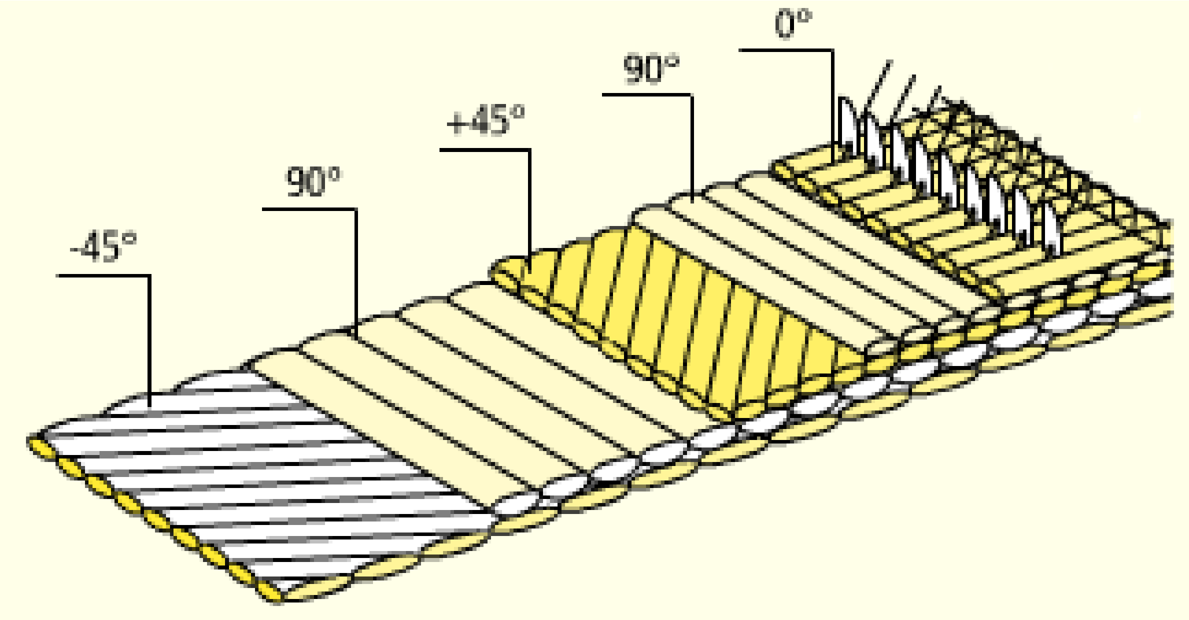
Szénszál gyártók elméleti évenkénti gyártó kapacitása (2015)



Terített szénszál tow előnyös jellemzői

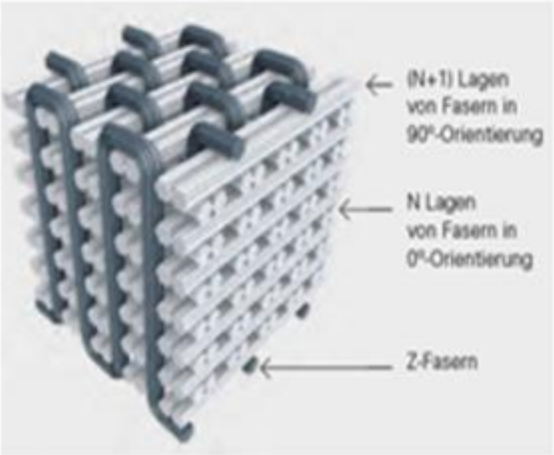




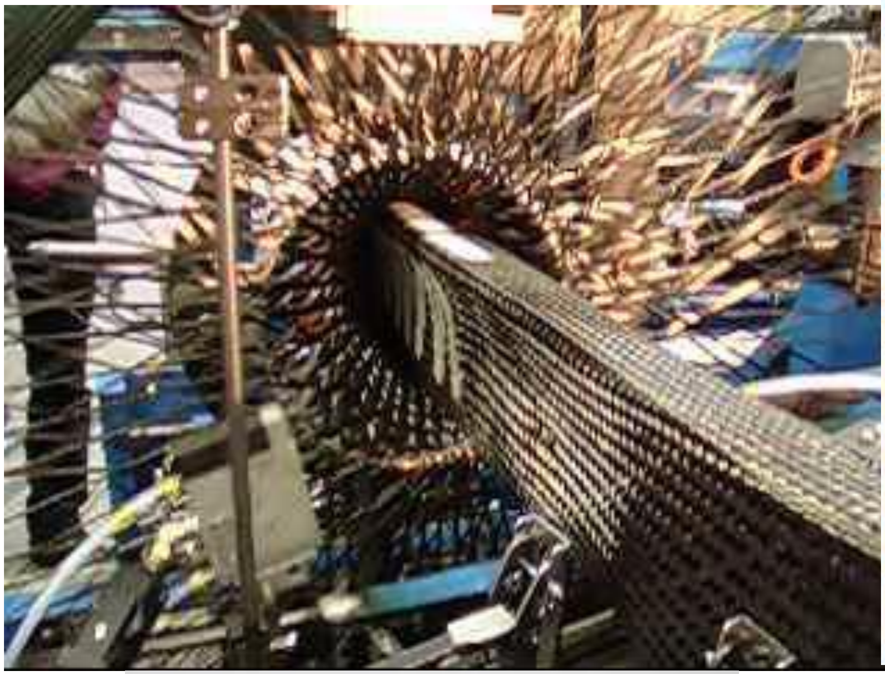


0°
90°
+45°
90°
-45°

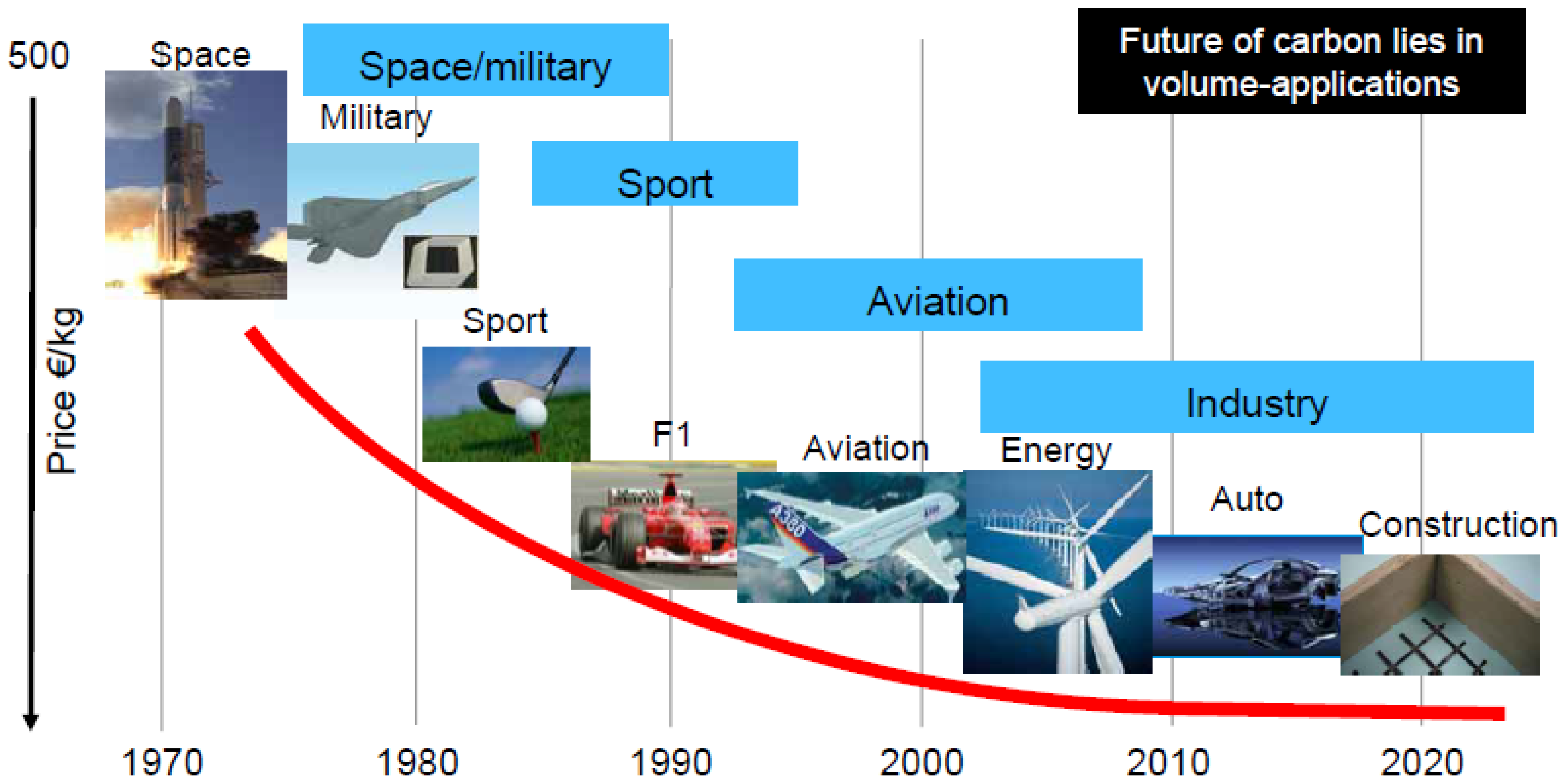
3D térbeli kelme szerkezetek



Braiding, Flechtverfahren, Fonatolás



Carbonfiber – evolution of prices



HPC have multiple areas of use; especially where weight reduction is important

Wind

Mobiletech

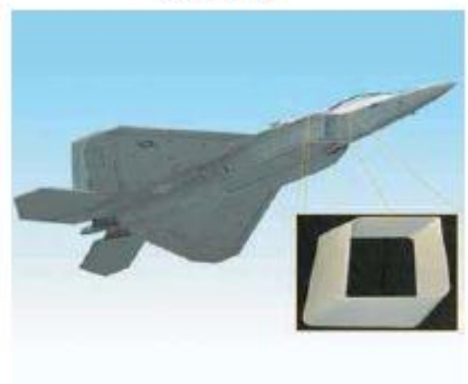
Exploration und piping

Marine

Space

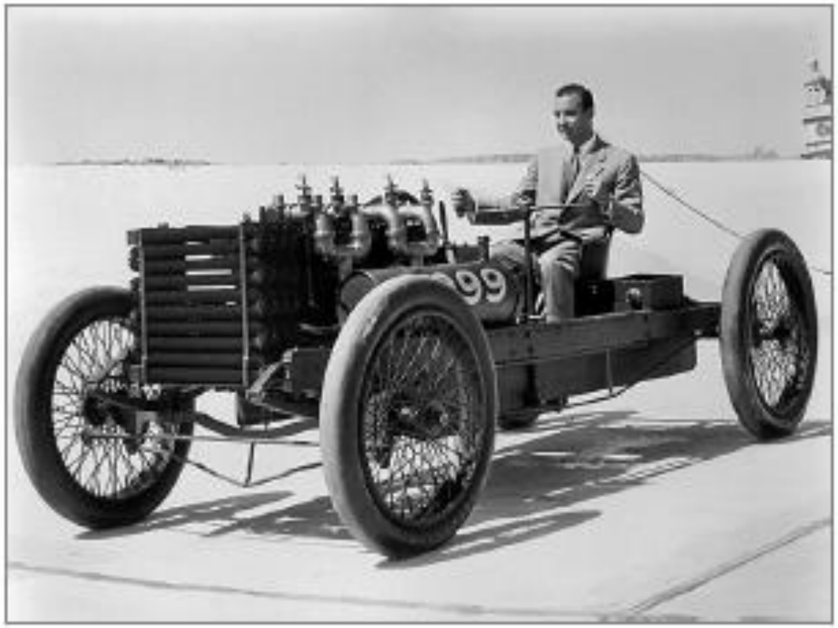
Aviation

Military



Sport

TECHNOLOGY: THE CONNECTION BETWEEN SPEED AND SAFETY



Low speed - High risk

High speed - Low risk

"It is all about probabilities. You can never make it safe. F1 is not safe but you can do a lot of work to reduce the probability of somebody getting hurt."

Max Mosley

Former FIA President

Resin Transfer Molding (RTM)

Preform deposition | Closing of the tools | Injection | Consolidation | Removal of the component

Injection
Light: 1-20 bar
HP: 150-200 bar

State-of-the-art resins

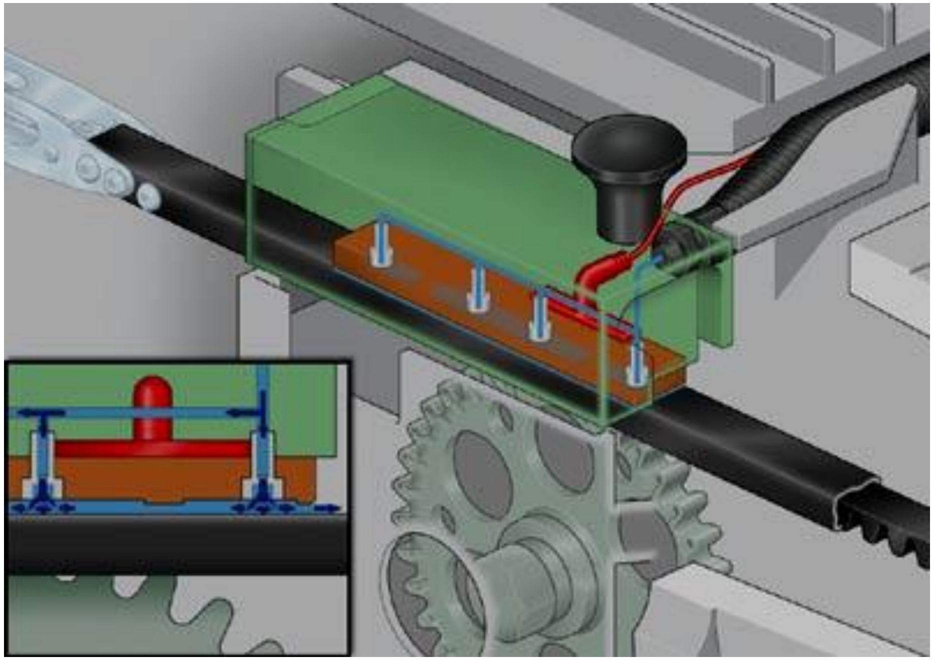
- epoxy
- polyester
- vinylester
- phenolic
- bismaleimides
- polyurethanes (future candidate)

DORNIER technology:

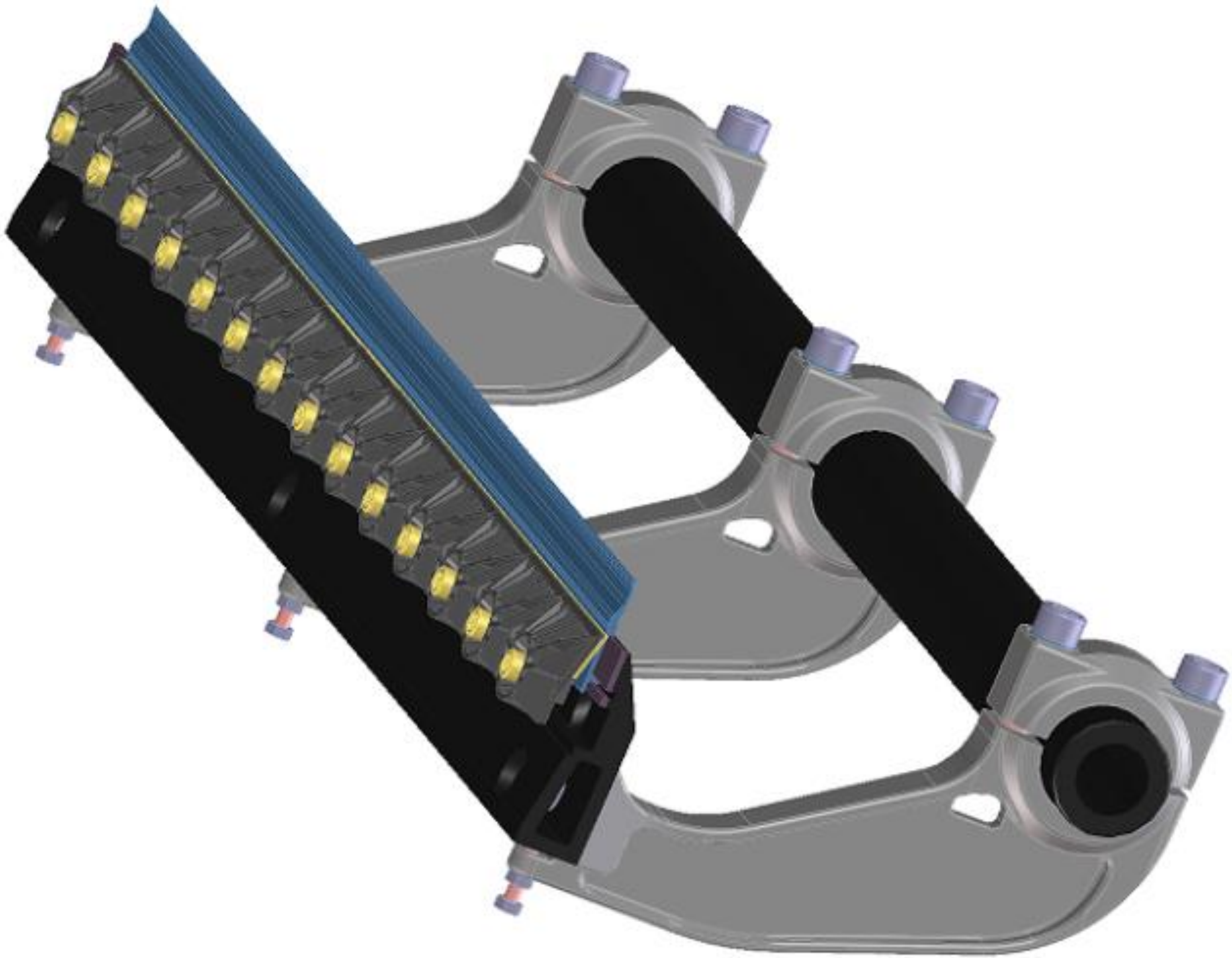
- ***Patented*** AirGuide® rapier rod is vertically guided by air stream

Your benefits:

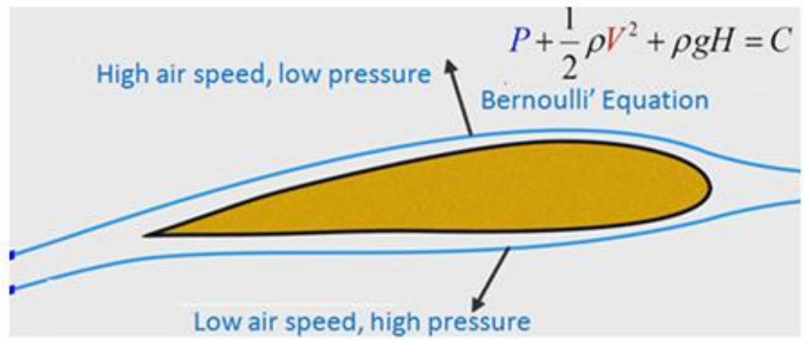
- Lower setting effort
- Time saving = 0.20% efficiency
- 0.20 € / 100,000 picks less spare parts costs
- 40 rpm higher speed
- 0.20% less seconds

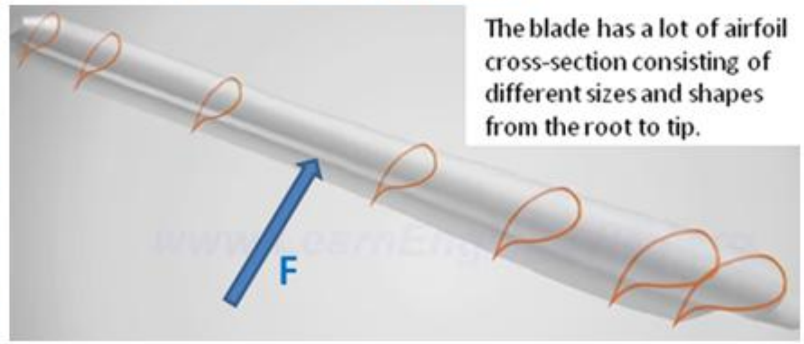


Carbon bars and drive shafts



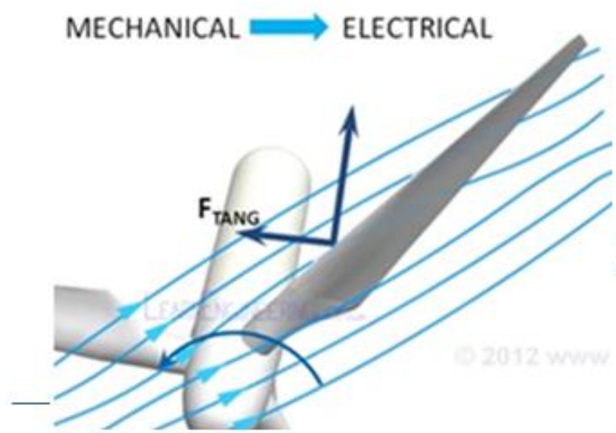
Bionik Airfoil principle (Eagle, Aircraft, Wind turbine)





Windmill

Wind turbine

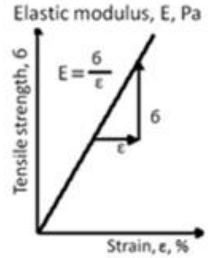


High bending stiffness CFRP spar caps with UD fiber orientacio

Bending stiffness (E I)

Flexural rigidity

E – elastic modulus



1 mm² ~ 15 000 carbon fiber

0,1 m² ~ 1,5 billion carbon fiber

I – area moment of inertia

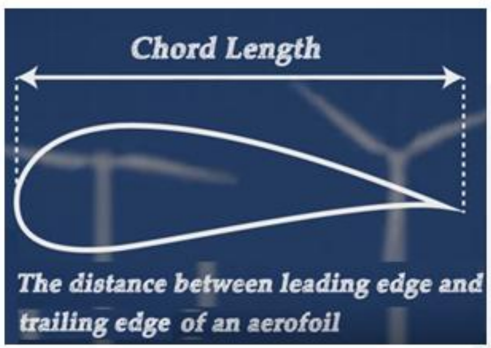
$$I_x = 2A\left(\frac{h}{2}\right)^2$$

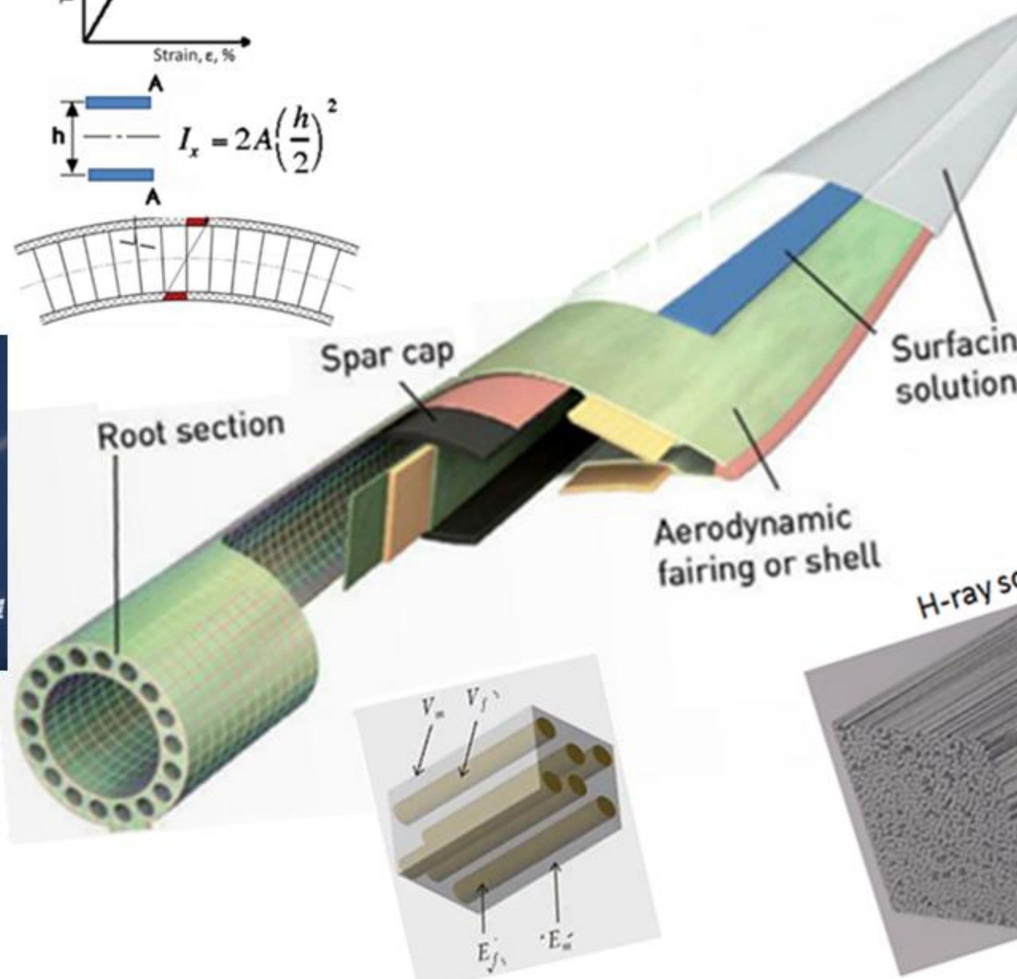
E I – bending stiffness

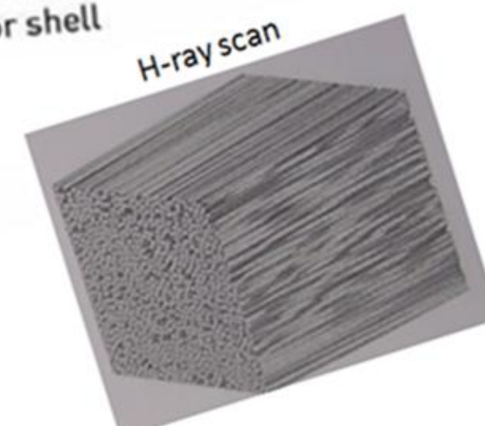
E I = M R

M – the moment about the natural axis

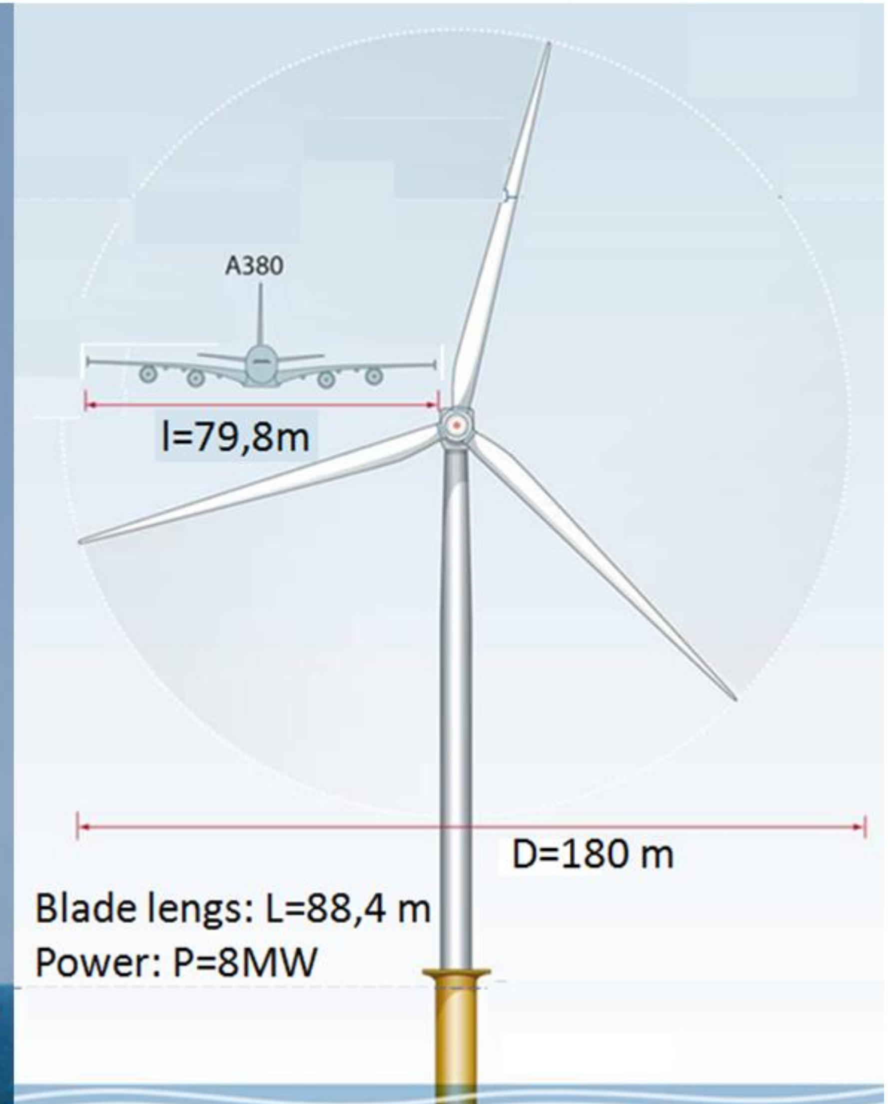
R – radius of curvature of the structure







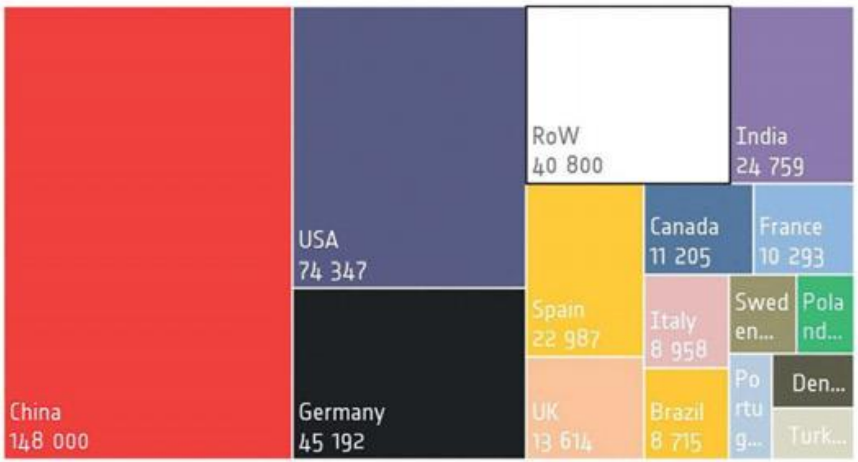
Offshore wind turbine and AIRBUS A 380 Airplane



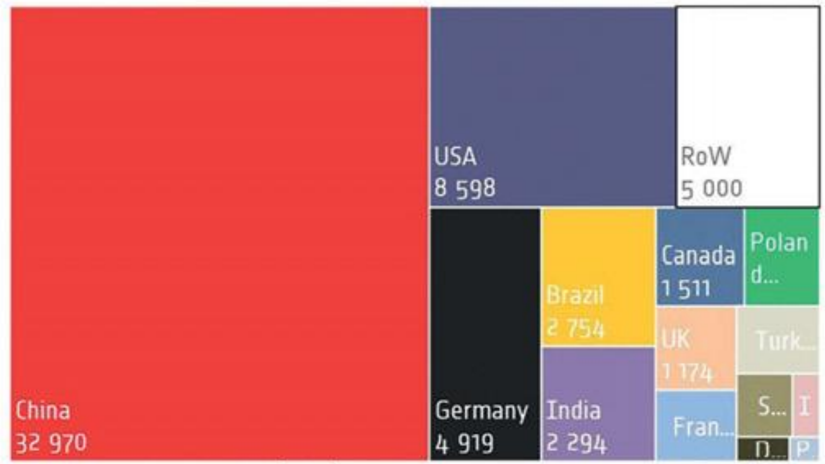
Gigantikus szénszálas kompozit merevítésű szélllapát (Hossza, l=88,4m)

Top 15 countries by total wind installations

Source: WWEA, February 2016

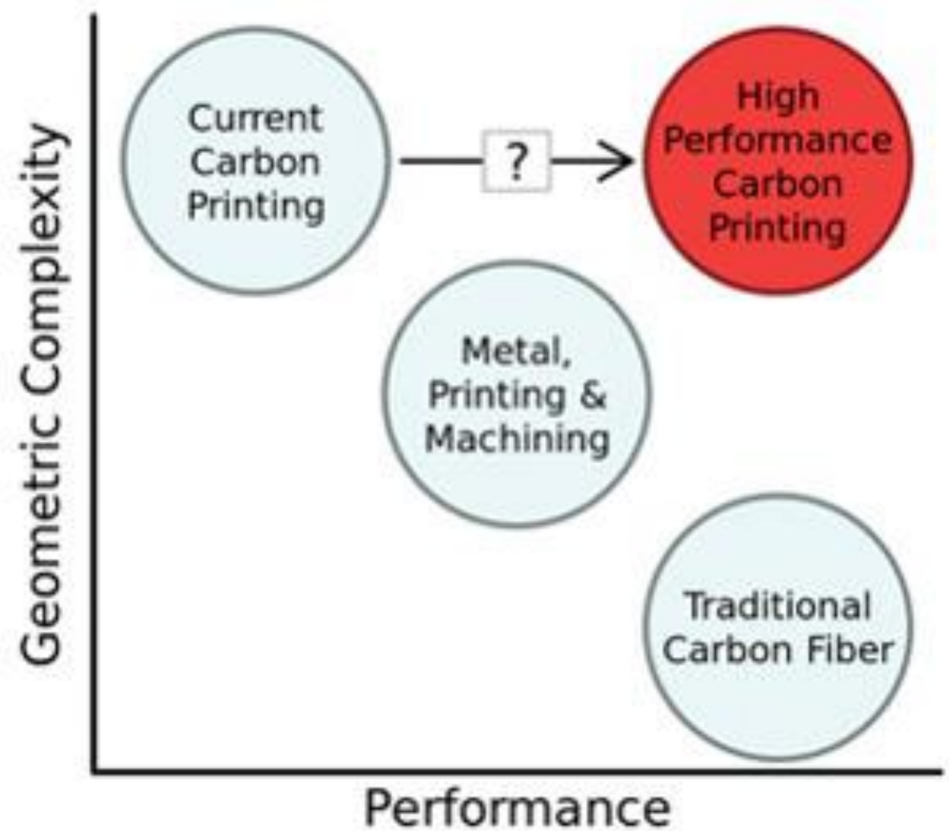


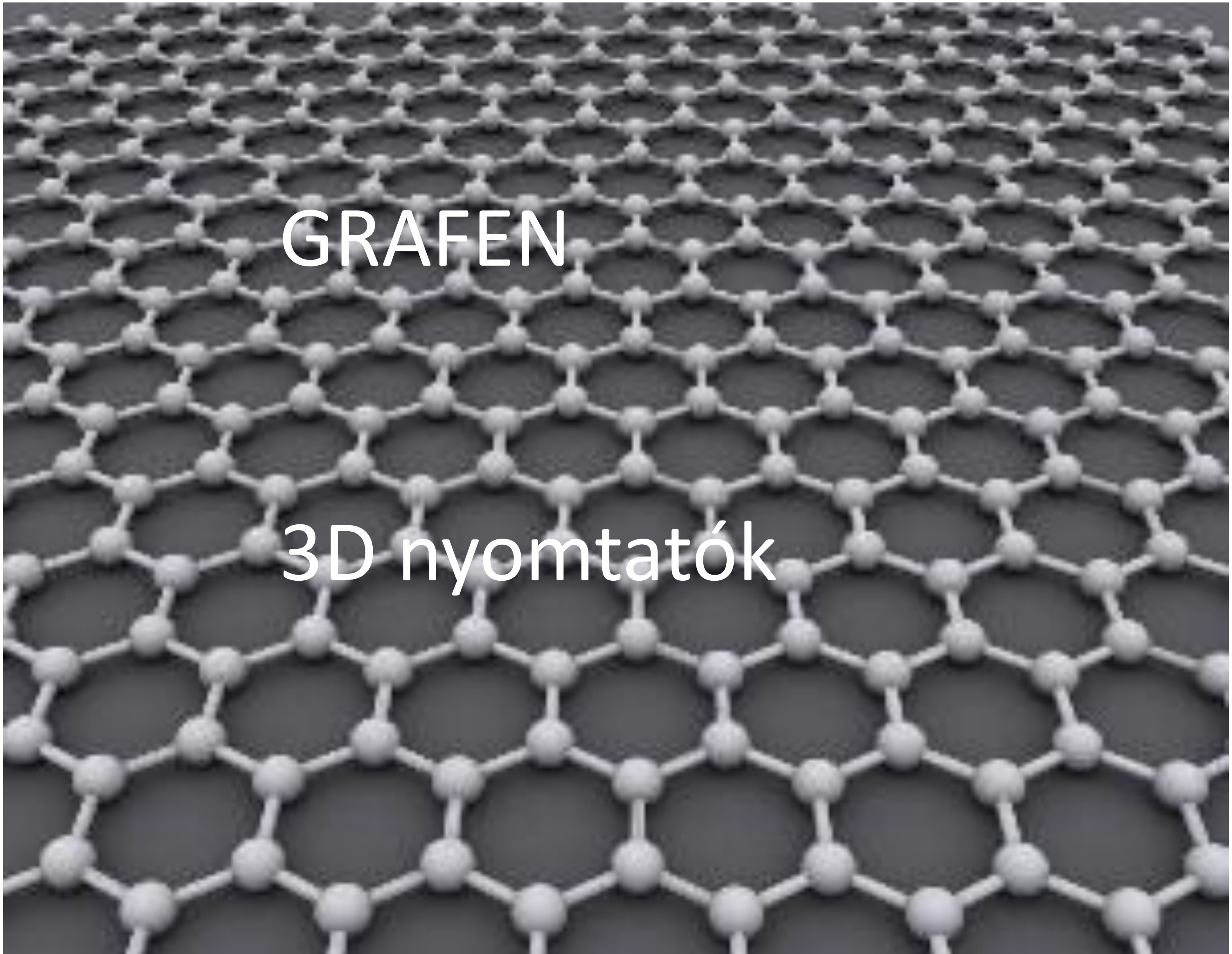
Total capacity end 2015 (MW)

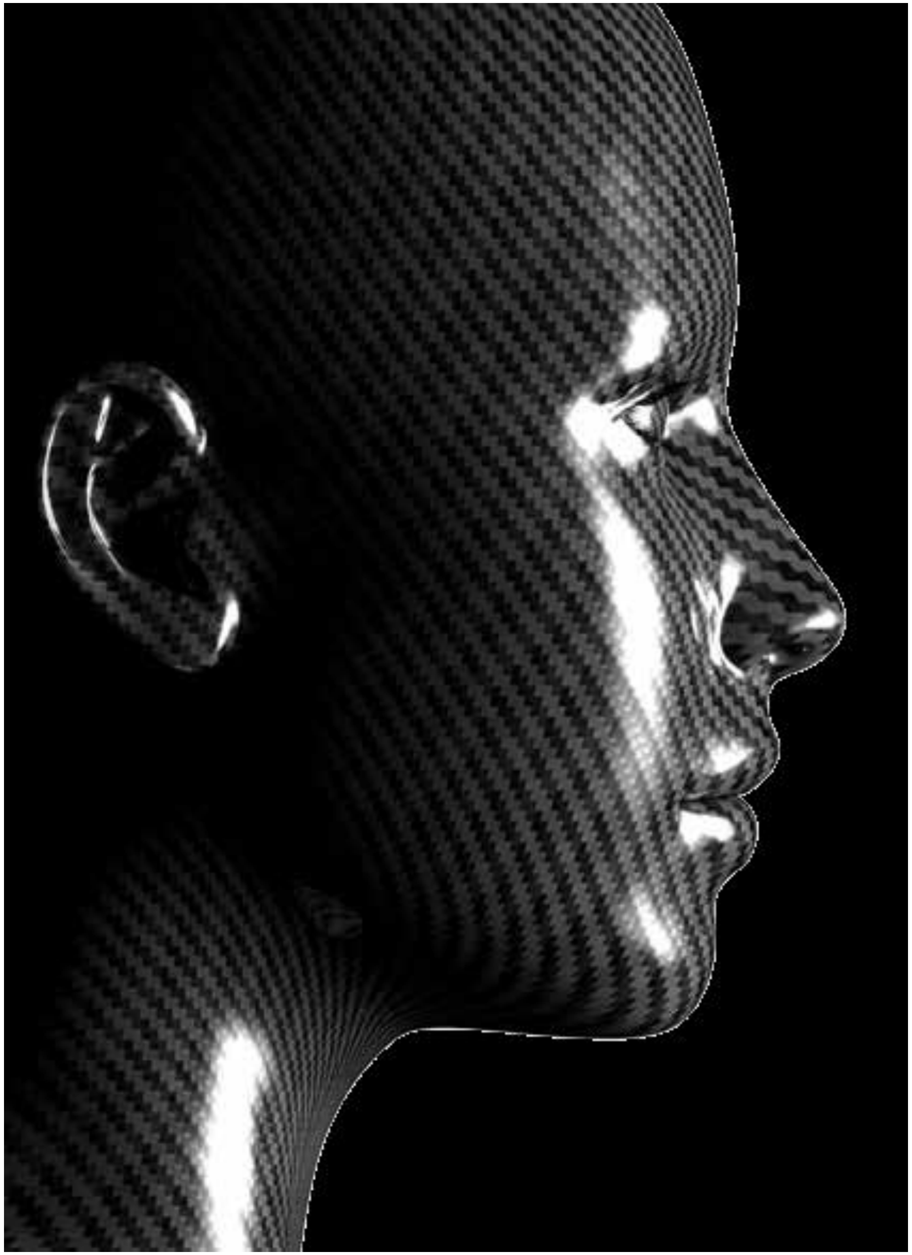


Added capacity end 2015 (MW)

Carbon fiber 3D printing could bring high performance and complexity




GRAFEN
3D nyomtatók



Köszönöm

az eddigi

figyelmet!