

**Aluminium
Consulting
Königswinter
Germany**

Future Applications for Aluminium Foil

Jürgen Hirsch (Prof. Dr.-Ing. habil.) - Aluminium Consulting - Königswinter / Germany

5th Global Aluminium Foil Roller Conference, 25 Jan 2019, Dubai, UAE

Outline

Introduction

- Aluminium Foil , processing, specific properties, classical applications
- Foil alloys : pure Al (99,5 1200), Al-Fe (8011, 8079, u.a.), Al-Fe-Mn (8xxx)
- Aluminium rolled to the extreme (6µm abd less) – effects of matt side and porosity
- Aluminium Foil for food packaging (lids, wrap, pharmacy blister, TetraPak antiseptic liquid package)

Recent innovations in Aluminium foil applications :

The EAFA/GLAFRI «Robert V Neher” Award nominees :

- 1)“Aluminum-Magnesium-Silicon alloy foil for explosion blocking and suppression material“ by Jianguo Li, Liyuan Su - School of Materials Science & Engineering, Beijing/China
- 3) “Super Oil and water Repellent Packaging Material “by Hiroyuki Nishikawa – TOYAL/Japan

- Future Applications for Aluminium Foil- *Jürgen Hirsch - 5th Global Aluminium Foil Roller Conference, 2019, Dubai, UAE*

Aluminium Foil , processing, specific properties, classical applications



Jogurt-lids, bottle foils caps, sealings



Pharma-Blister



Food packaging (butter, cheeses, e.t.c.)



Aseptic liquid packaging



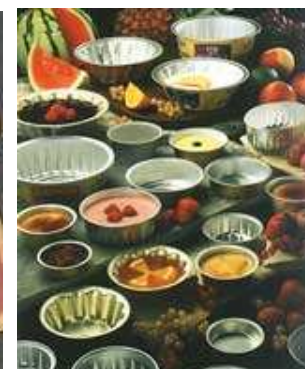
Chocolate wrap



Food cups and lids



Dog/Cat food container



Heatable food container



Classical household foil

Applications



Aseptic Liquid
Packaging

„Pure“- Aluminium:

soft, always supported by plastic or paper in laminate
(e.g. coffee packaging, cigarette foil, soup pouch, aseptic liquid packaging, blister – push through foil, technical applications)



Cigarette Inner Liner



Blister packs

Applications

Al / Fe:

high strength, high ductility, push through-resistant



Chocolate wrapping



Embossed
yoghurt lids



Bottleneck wrapping

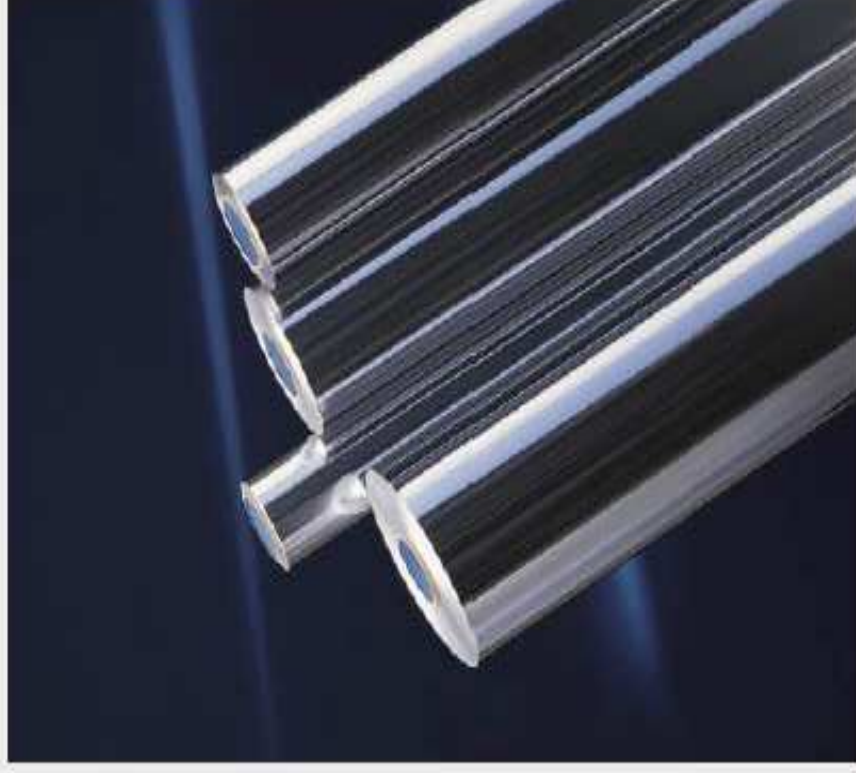
Applications

Al / Fe / Mn:

highest strength, high ductility, push through-resistant



Unembossed yoghurt lids

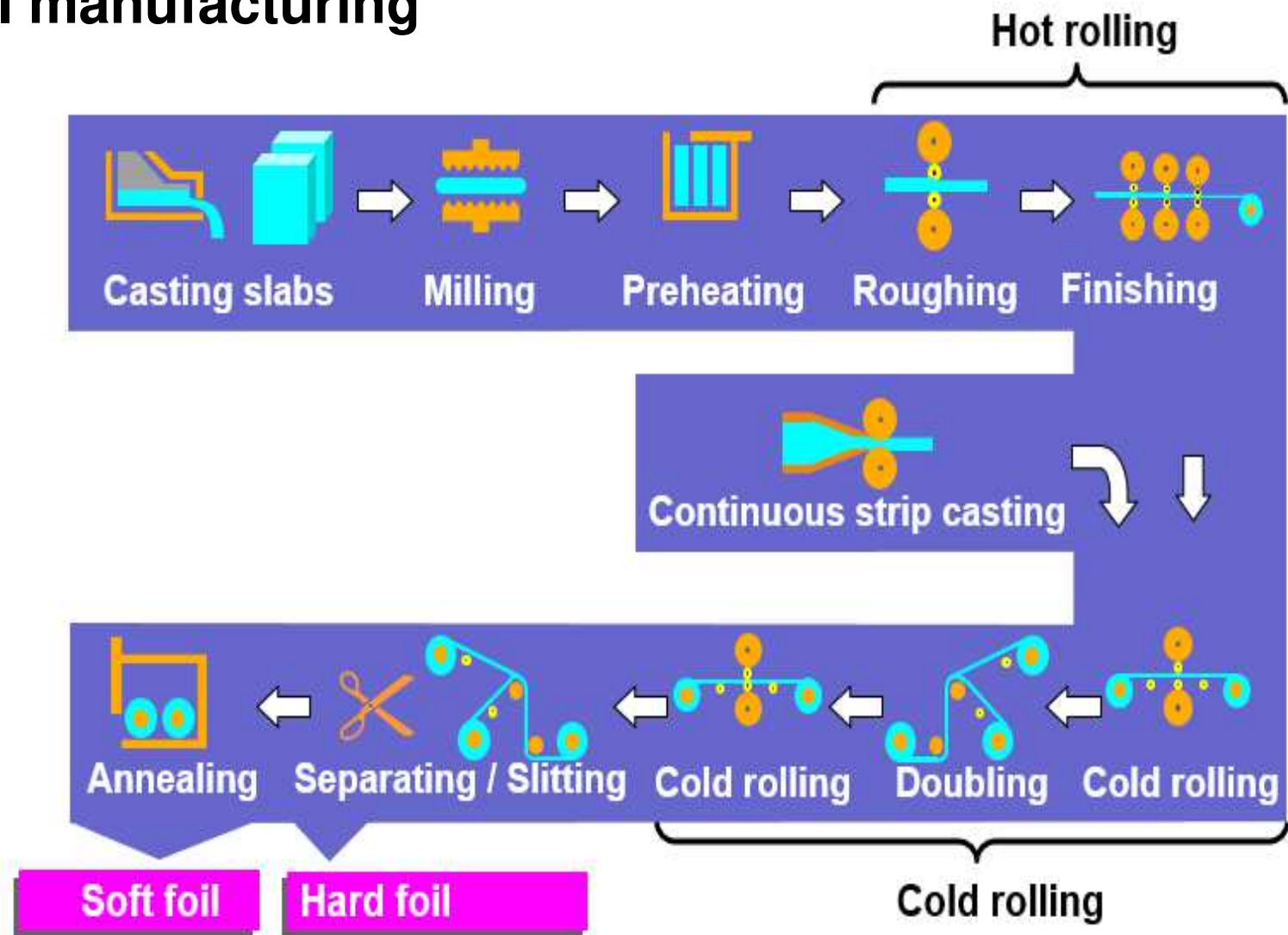


Ultrastrong Household Foil

Process chain of foil manufacturing

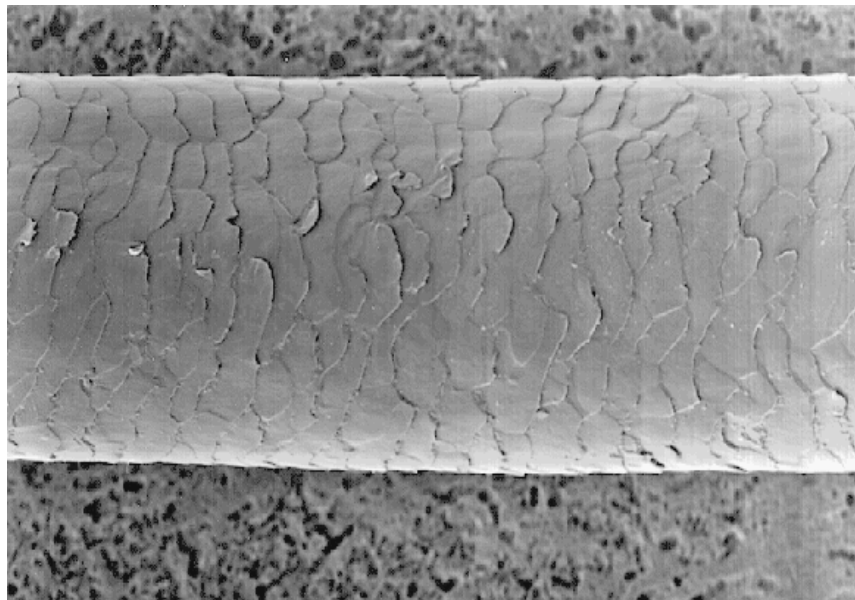


5 passes	650 µm → 270 µm
	270 µm → 130 µm
	130 µm → 64 µm
	64 µm → 33 µm
	33 µm → 14,5 µm
Doubling	
Final pass	2 x 14,5 µm → 2 x 6,3 µm



size comparison : human hair and foil

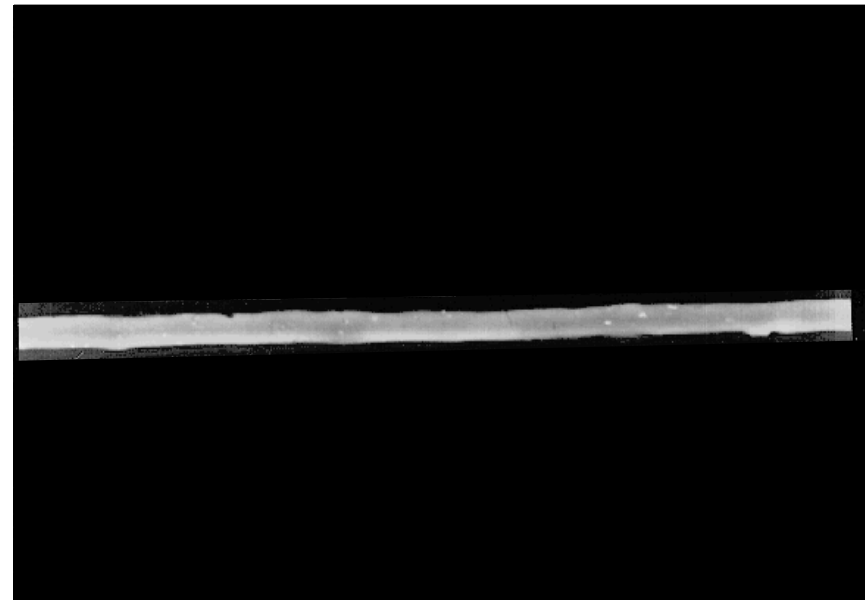
human hair



600:1

10µm

foil for aseptic packages
(6.35µm thick)

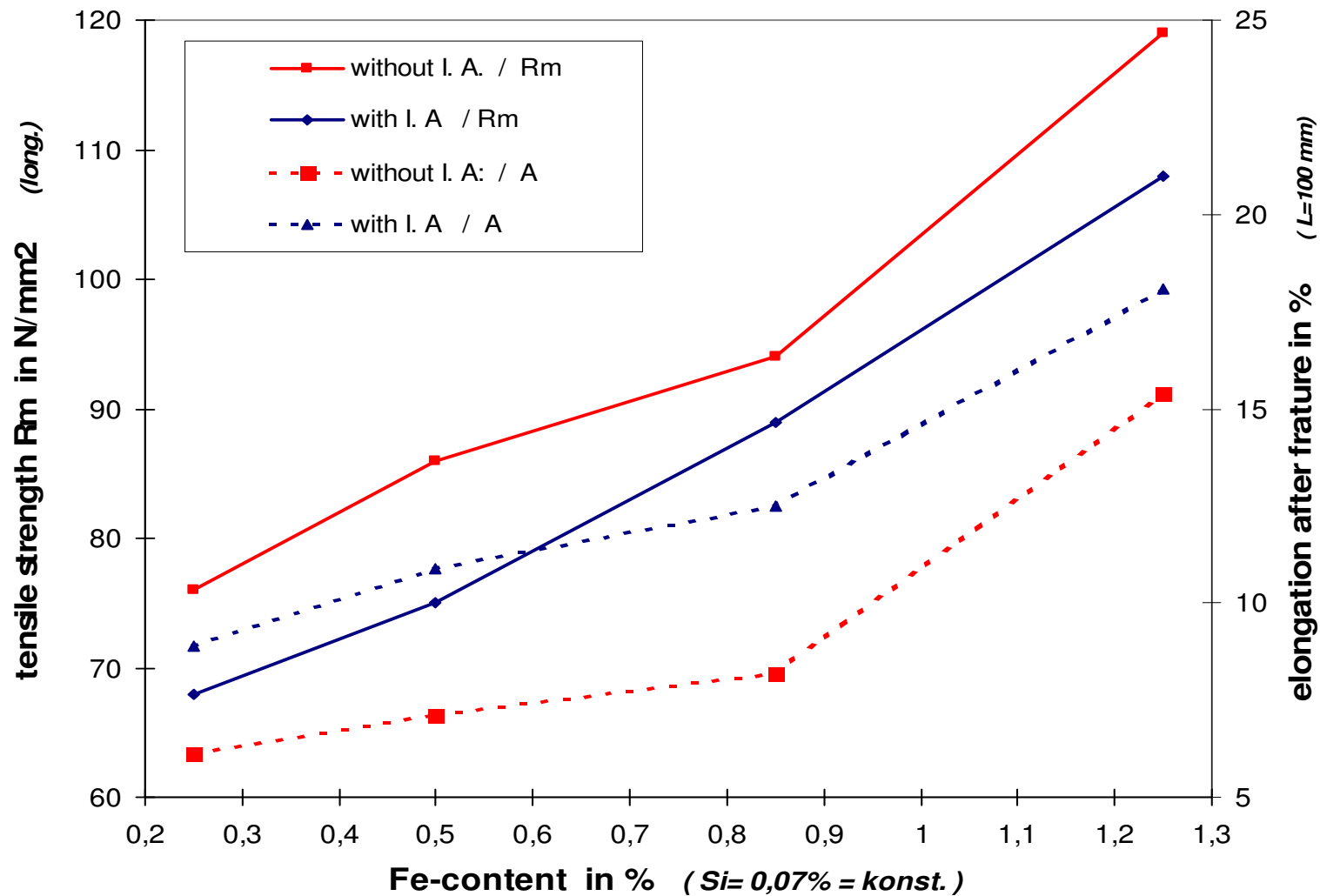


600:1

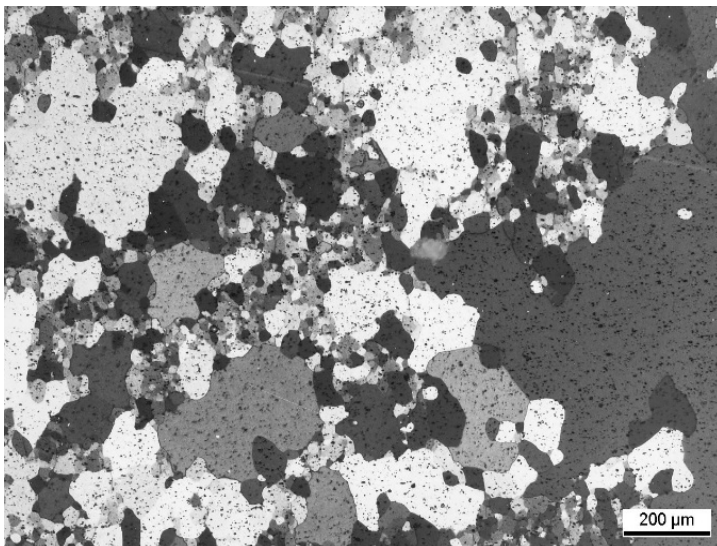
10µm

Influence of iron on strength and elongation

Influence of Fe on strength and elongation in the annealed condition (=Coil 350°C / thickness = 50 µm)

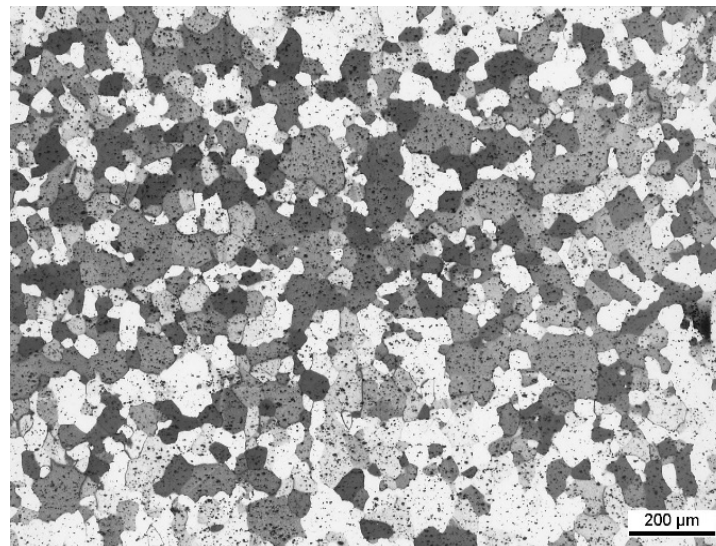


Aluminium Foil production: Effect of Fe content on recrystallization



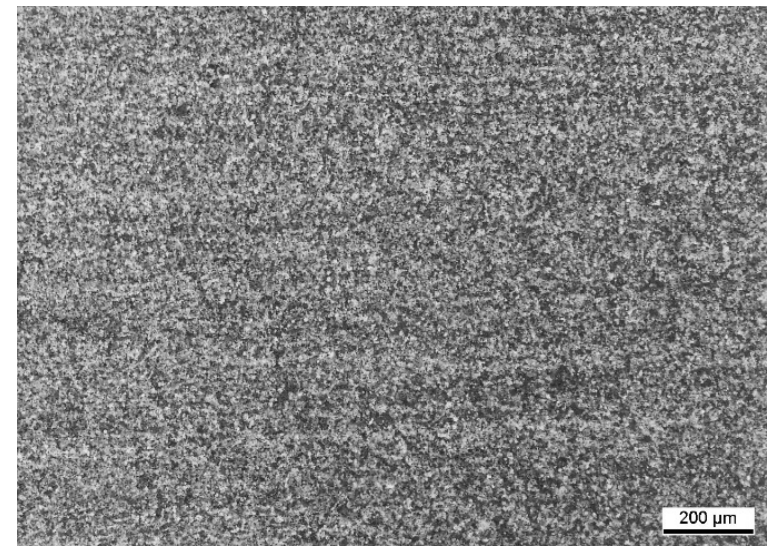
Fe=0,25%

AA 1050



Fe=0,85%

AA 8079



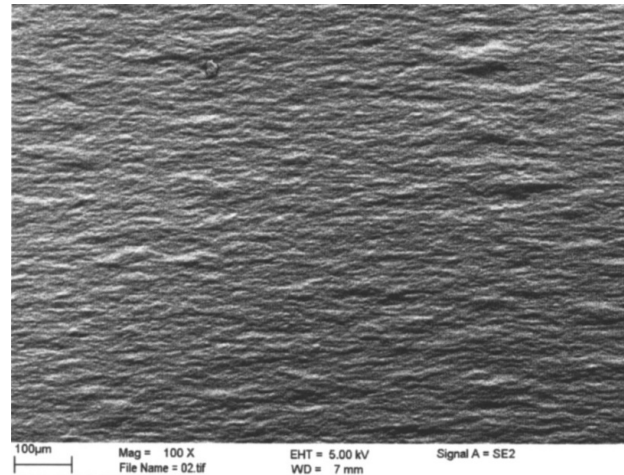
Fe=1,25%

AA 8021

Aluminium Foil production: mat/Shiny -side by double rolling



Influence of the Fe-content on the mat -side surface corrugation

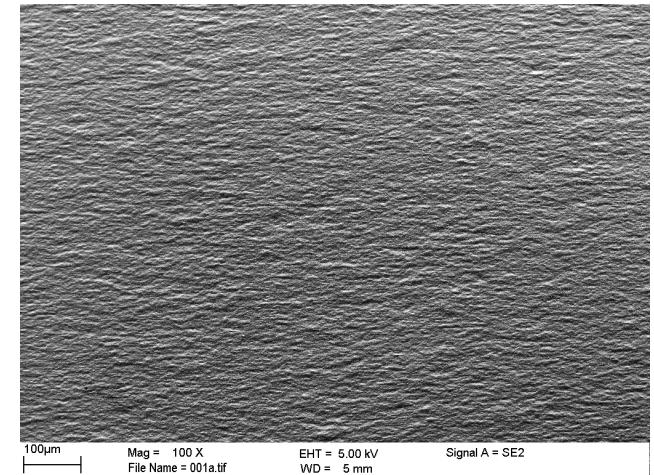


99/52 - coil-centre

(12500 pores/m² *;

**$R_{p0,2} + R_m$: 140
N/mm²)**

*** Number of pores counted with PIA**



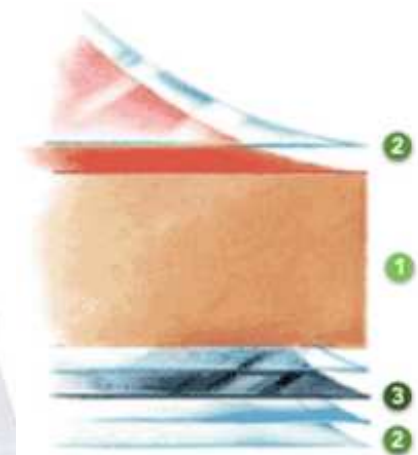
98/90 - coil-centre

**(0 pores/m² *; $R_{p0,2}$:
148 N/mm², R_m : 170
N/mm²)**

Aluminium foil helps to save the food (non-frigerated!)

1/3 of all food is lost without being consumed

Aluminium packaging keeps food fresh longer, reduces cooling need and protects food better during transportation and storage

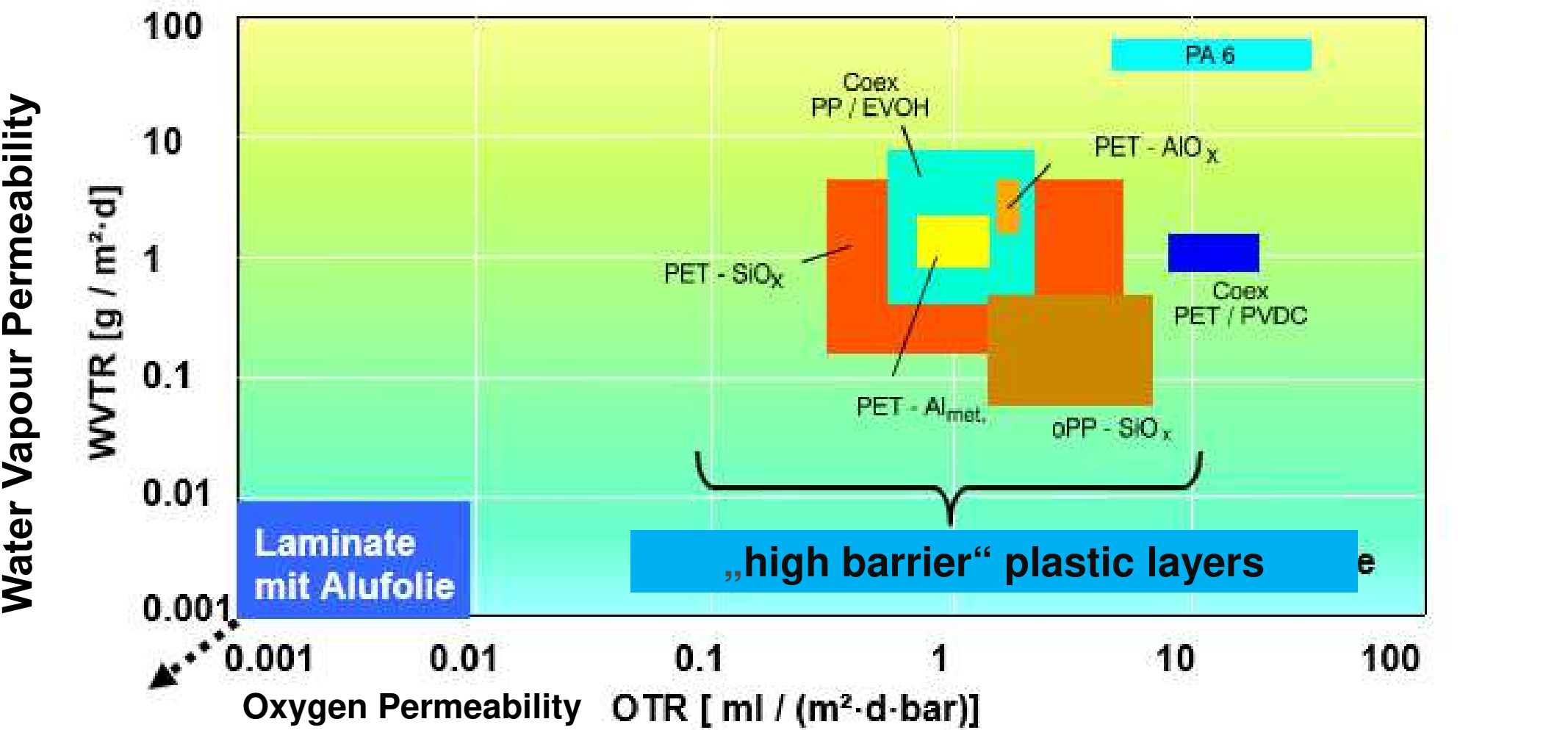


Packaging material

- ① Cardboard
- ② Polyethylene (plastic)
- ③ Aluminium

A 6 micrometer layer of aluminium protects against oxygen, light and preserves aroma

Permeability of „high barrier“ plastic layers and Aluminium Foil



Flexible packaging materials – Functions of the single layers

Printing (information and attractiveness)

Film (mechanical support)

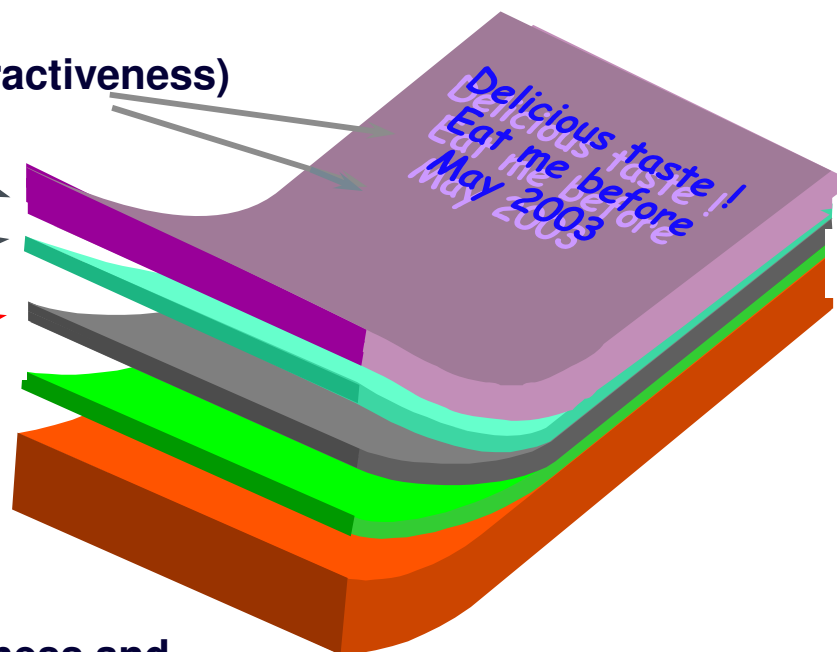
(or reverse printing

Adhesive

Aluminium foil
(suppresses any transport
of mater and the permission
of light)

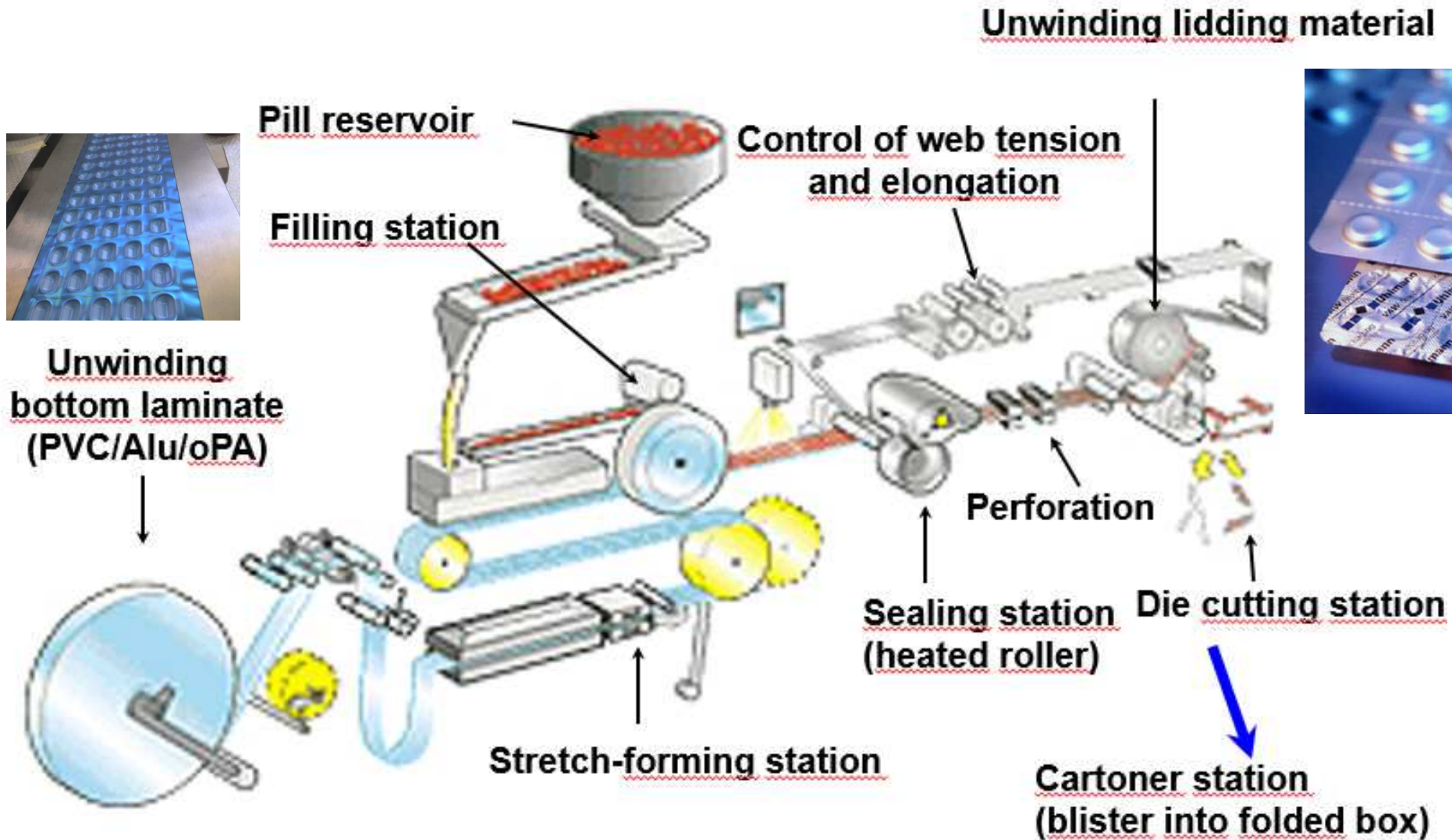
Adhesive

Thermoplastic sealant layer
(improves also laminate stiffness and
puncture resistance)



* Example: Laminate for roasted and ground vacuum-packed coffee
PET 12 μm /reverse printing/adhesive 4 μm /aluminium foil 6-9 μm /
adhesive 3 μm /PE-film 50-70 μm

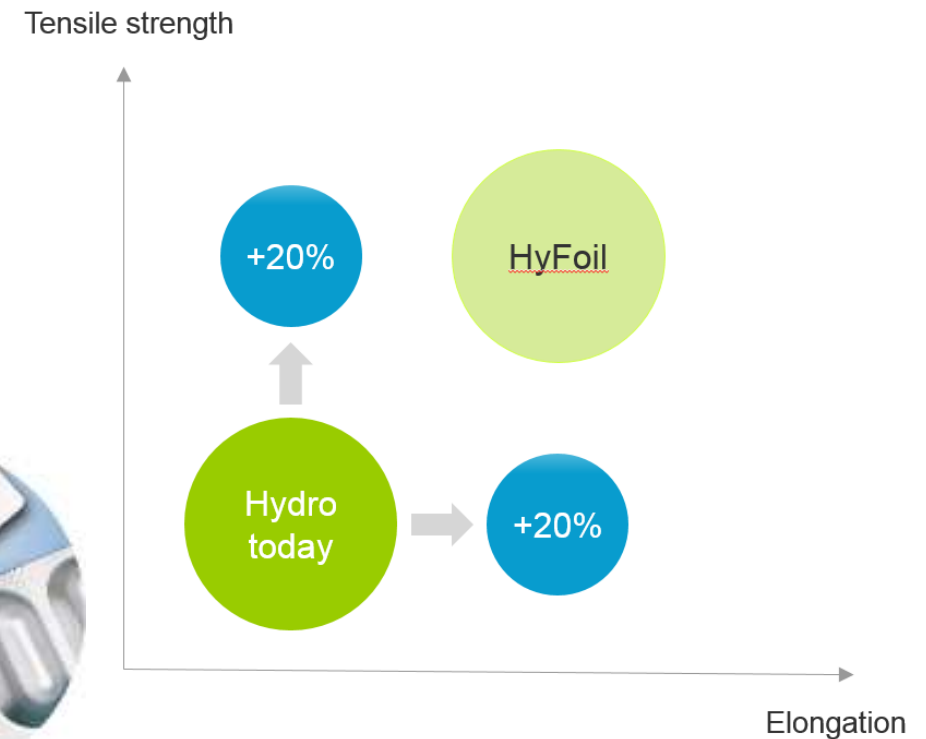
Form-Fill-Sealing Machine (FFS) for tropical blister packaging



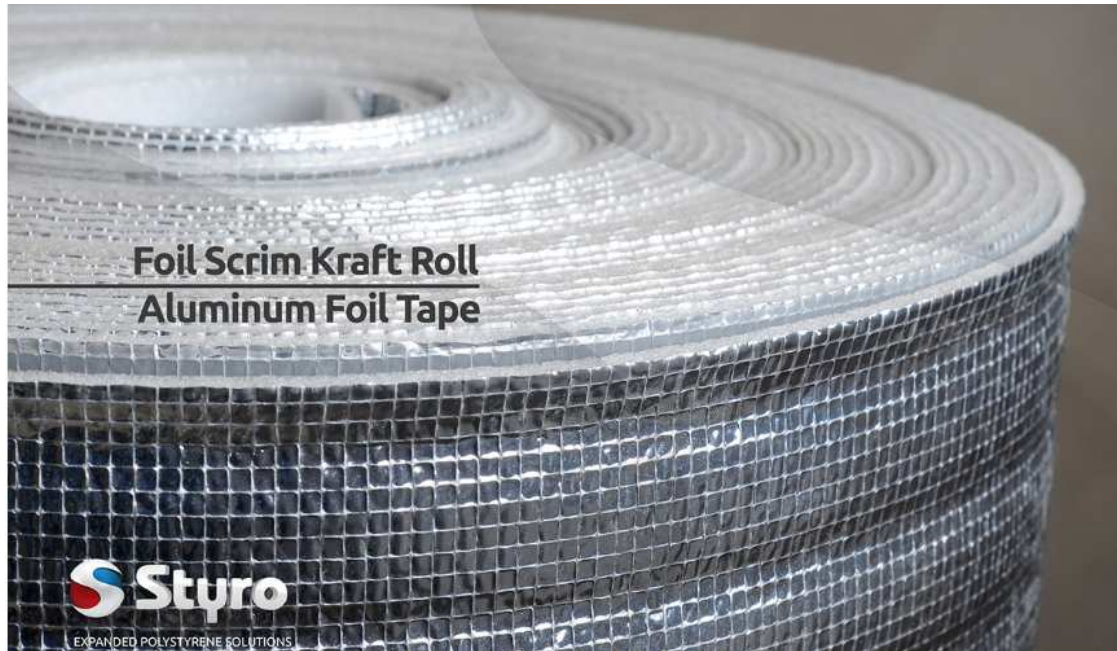
Step change in efficiency and quality of foil products

High-grading our leading high-end foil by further enhancing foil strength and elongation

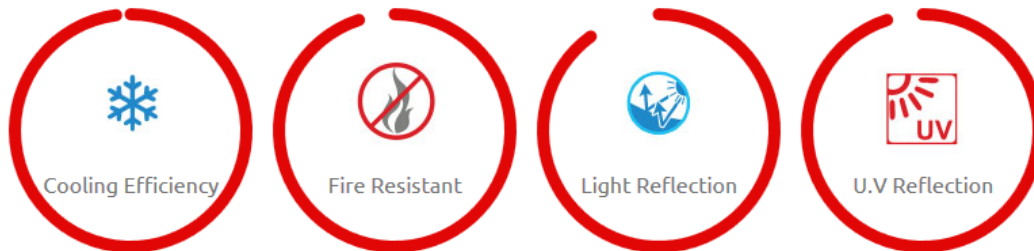
- Next generation converting foil: sophisticated alloy combined with shorter production routing
- Significant customer advantages
 - Faster speed on their converting lines
 - Thinner gauges
 - Better technical properties
- Proof of concept ongoing



Aluminium foil in furnace insulations



Foil Scrim Kraft Roll Aluminum Foil Tape



• Applications and Usage

- Lamination for Steam boiler , Burners , Furnace , Chimneys
- Improves aesthetic look on utility piping
- Protect the insulation from Moisture, humidity and friability
- Improves the life , durability of the insulation
- light weight , Easy work-ability

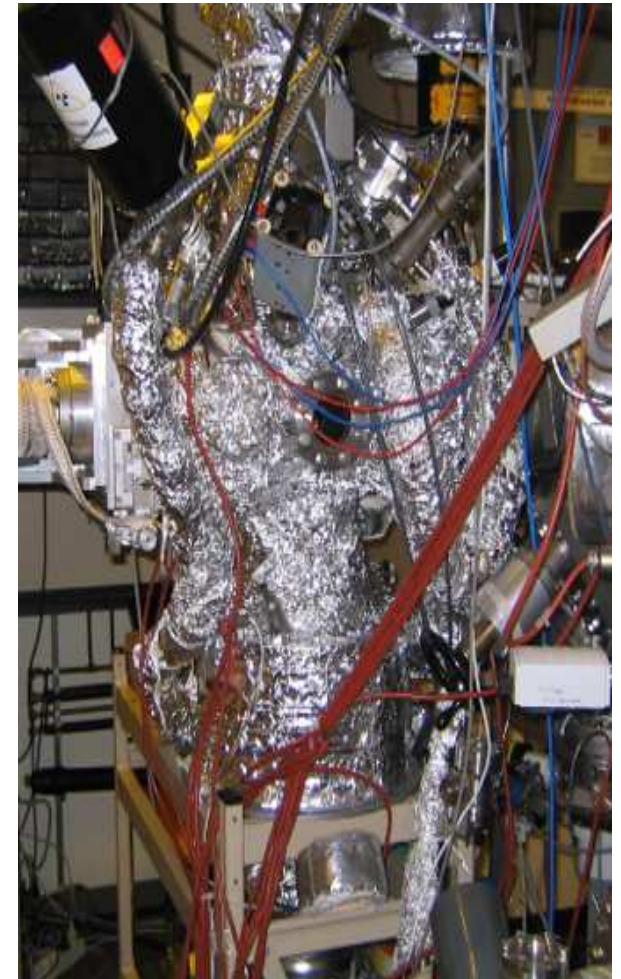
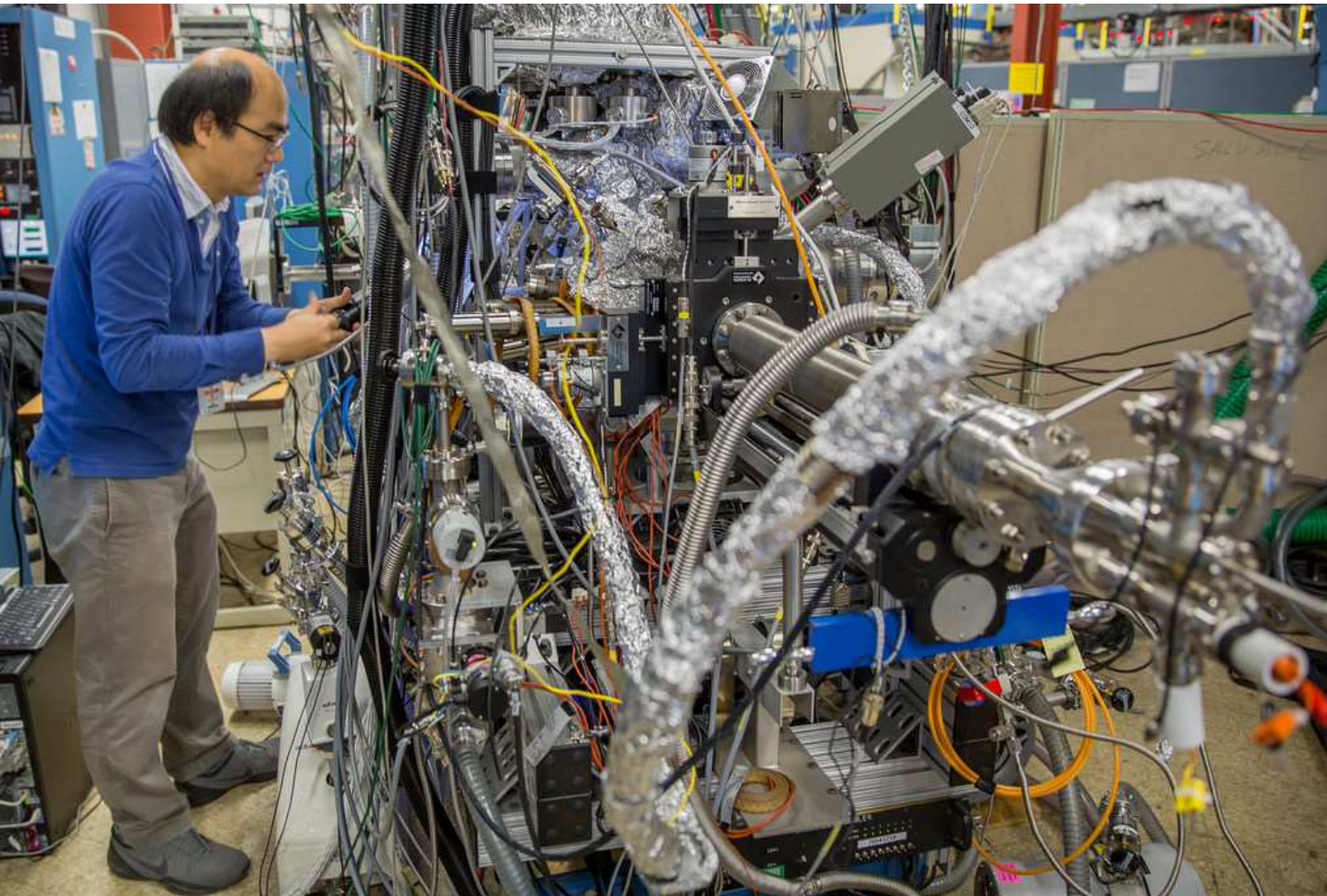
Benefits

- Resiliency, Cushioning, Shock Absorption, Flexibility, Abrasion Resistance, Light Weight, Oil Resistant, Thermal Insulation, Sound / Vibration Dampener, Wide Temperature Range

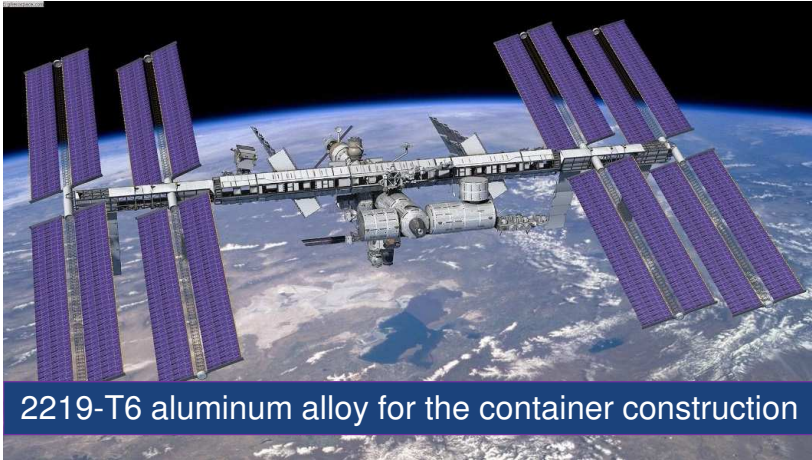
Aluminium foil in insulations



Aluminium foil in insulations



Aluminium foil in Space constructions



Aluminium foil in health applications



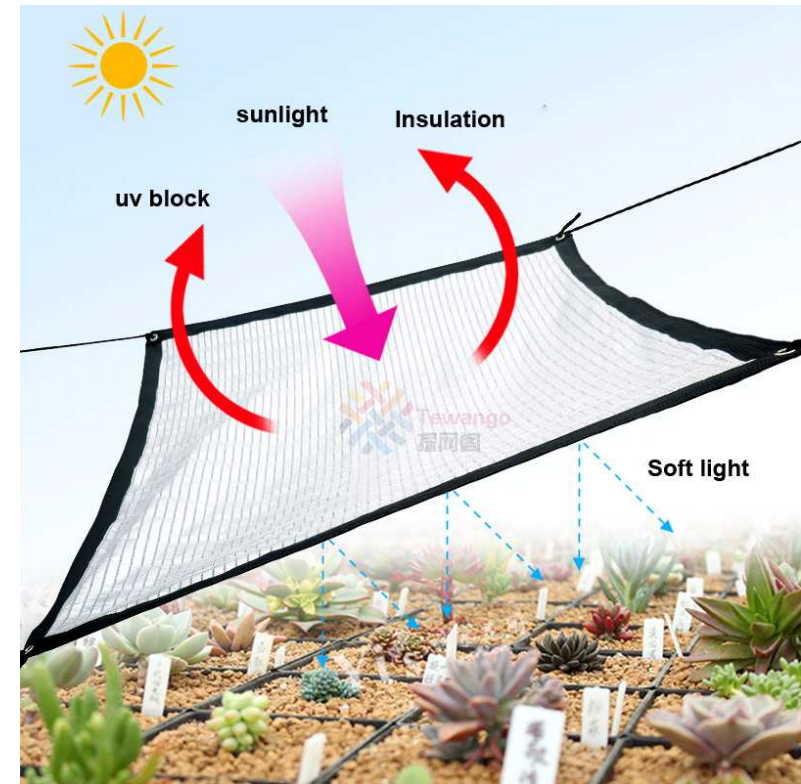
Aluminium foil is recommended as :

- burned skin protection
- joint pain relieve
- releases muscle tension

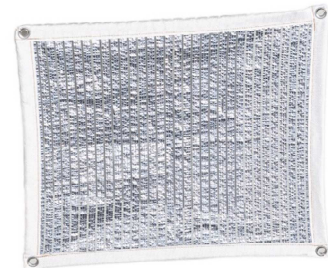
Aluminium foil in plant protection



Wrapped around the trunk, Aluminium foil protects young trees from insects, snails and rodents. Aluminium foil also can help in frost protection. Alufoil attachede as flutter bands scare away birds.



Greenhouse Sun Protection
Aluminum Foil Shade Sail 75%
UV Block Succulent Plants-in
Shade (source: Tewango)

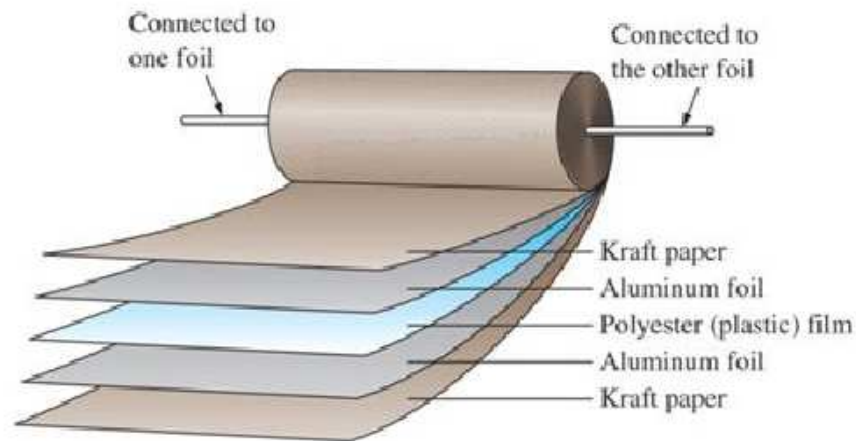
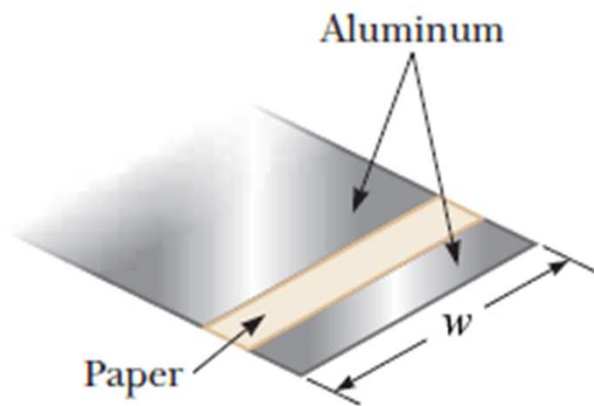
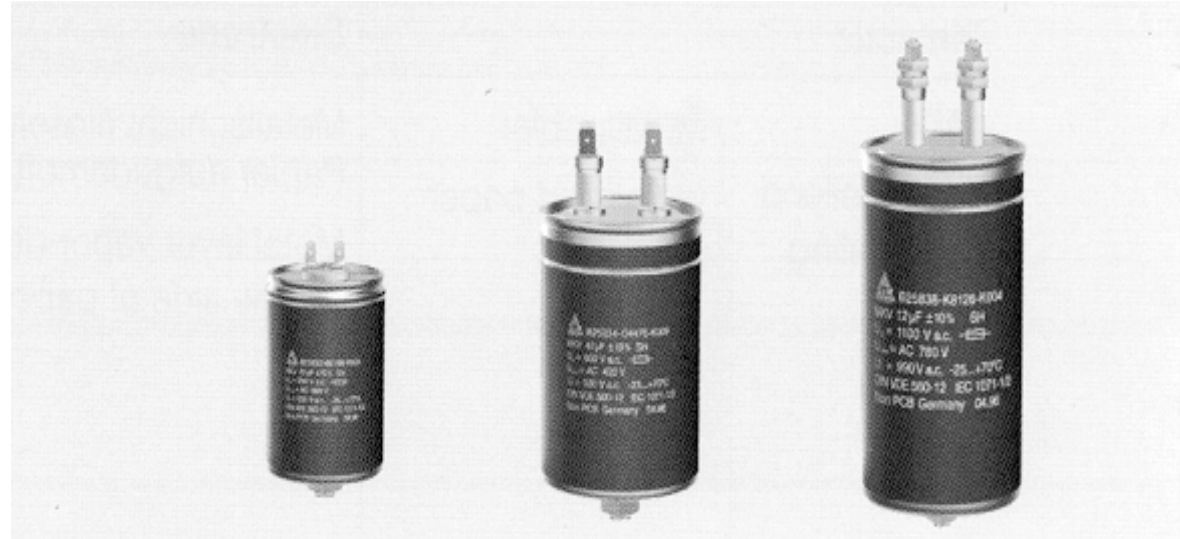


Aluminium foil as low-cost sun collector

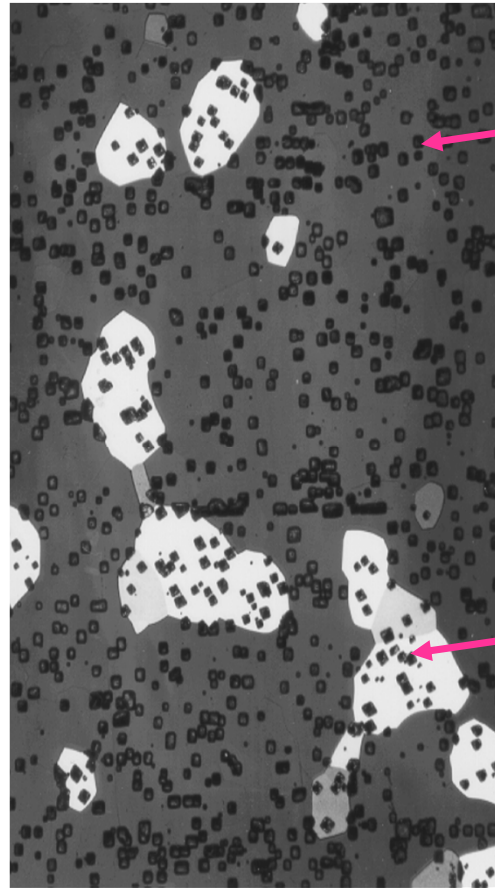
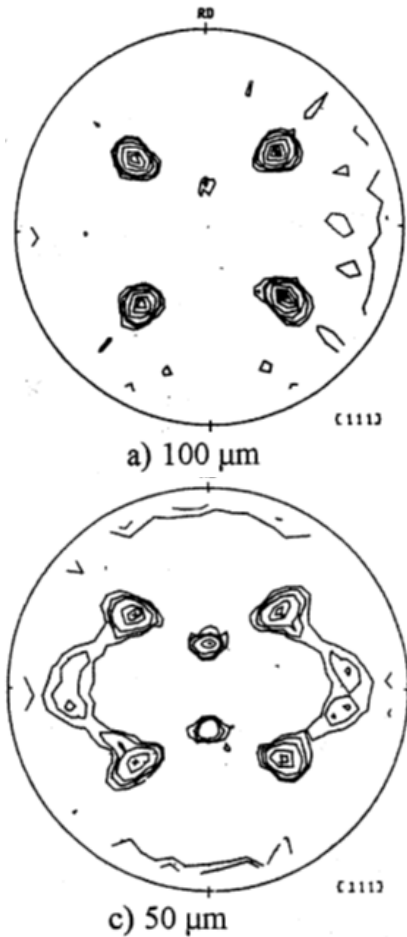


Simplest Solar Cooker Ever! (cardboard and Foil Oven)

Aluminium foil in electrolytic capacitors

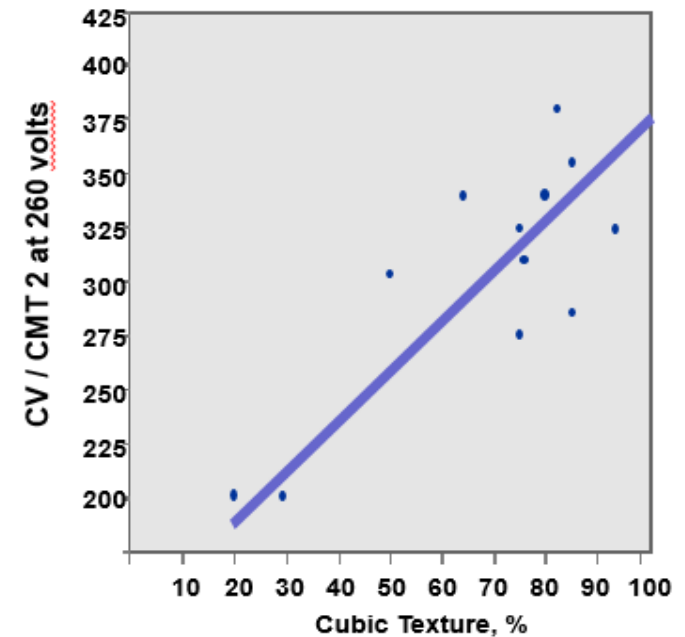
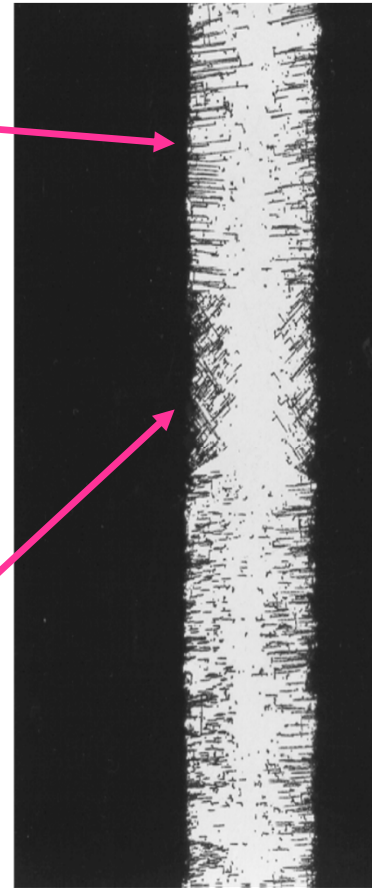


Cube texture effect in etched HP Aluminum 100μm condenser foil



cube

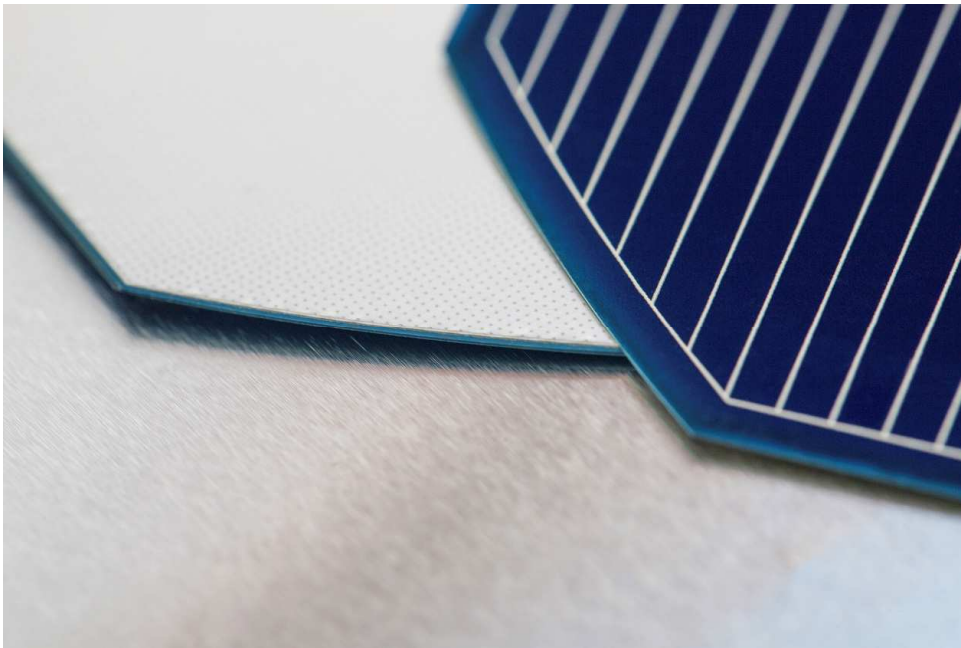
R



High-efficiency Industrial Solar Cells with Foil Metallization

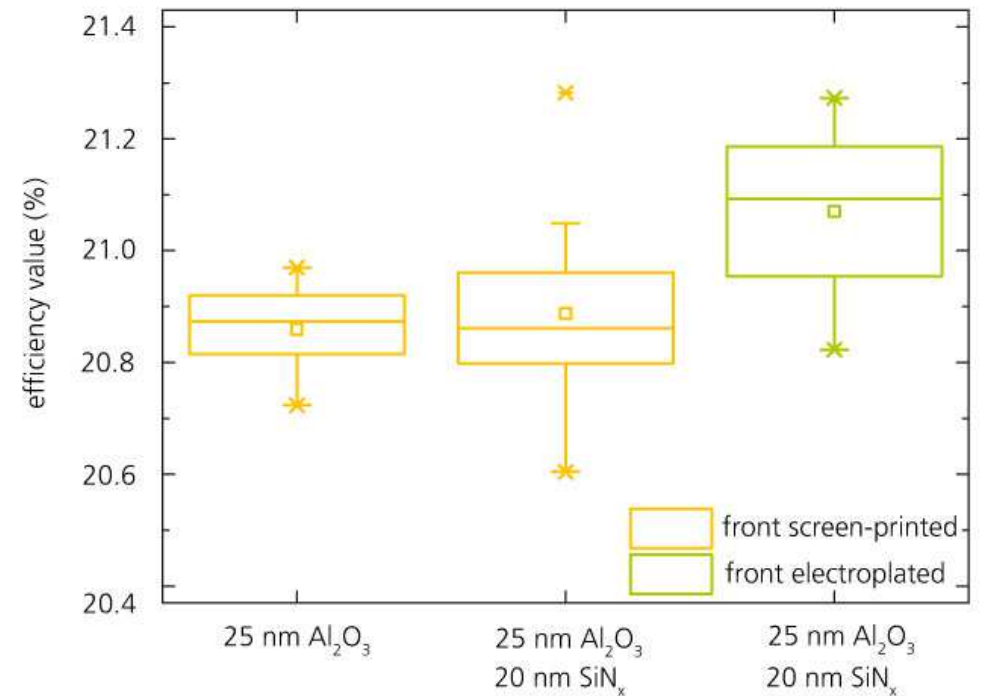


“FolMet” - Foil Metallization for Crystalline Silicon Solar Cells /*



Front and back of a 156 x 156 mm² industrial solar cell with a back-surface passivation layer and laser-welded contacts of conventional aluminium foil.

/* © Fraunhofer ISE



Efficiency of industrial PERC solar cells without busbars, with back-surface foil metallization, with/without a thinner SiN_x protective layer on the back surface, printed / fired (yellow) or galvanically plated (green) front metallization

Aluminium foil for current collectors in Lithium Ion batteries



For Lithium Ion batteries Aluminium foil is used as a current collector for cathodes in Li-ion cells and as connector :

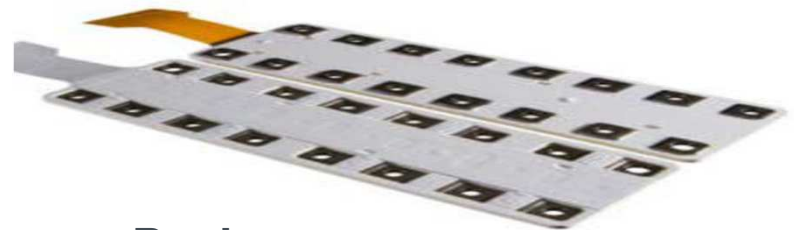
20 μm Aluminium foil (EN AW 1085, H18) form high-purity metal quality with a special surface.



Connector Foil



Cathode Foil

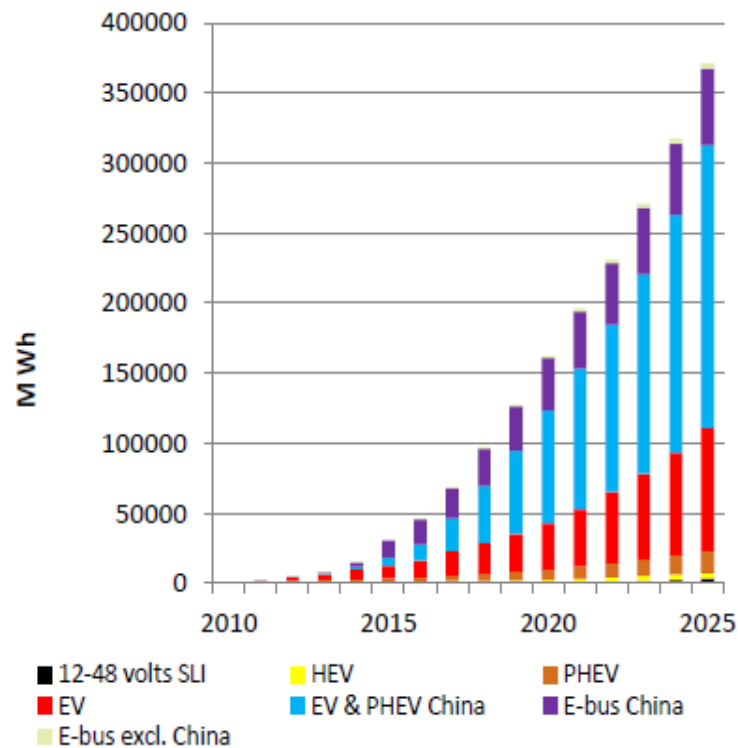


Busbar

BATTERYDEMAND FOR AUTOMOTIVE - 2025 FORECASTS

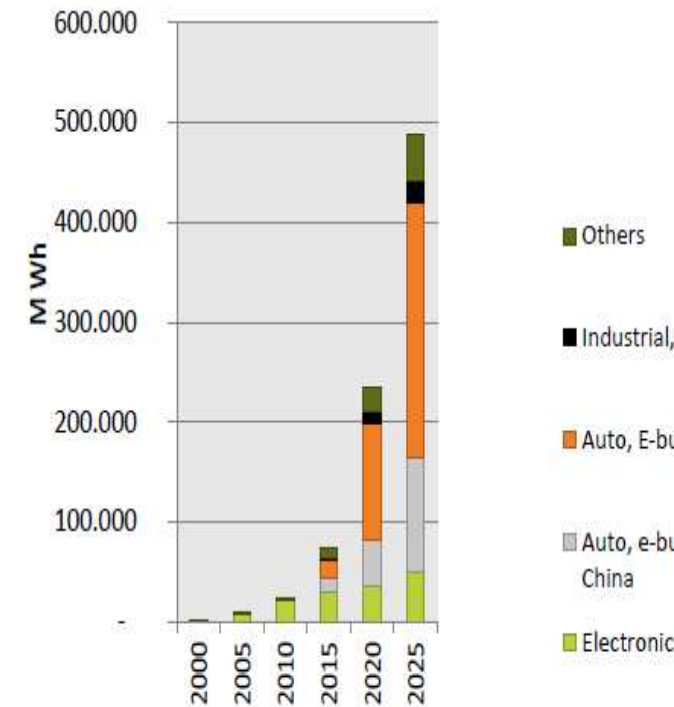
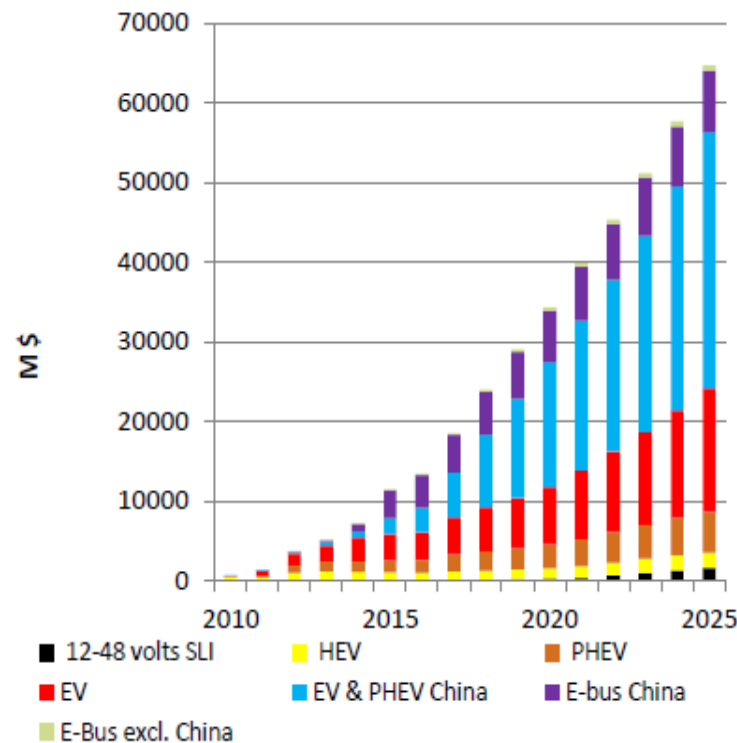
Li-ion for EV, HEV & P-HEV Battery needs (MWh)

CAGR 2017-2025: +23%



Li-ion for EV, HEV & P-HEV Battery needs (M\$)

CAGR 2017-2025: +17%



Others: medical devices, power tools, gardening tools, e-bikes...

Source: AVICENNE Energy 2018

Source:

Christophe PILLOT
+ 33 1 44 55 19 90
c.pillot@avicenne.com

Recent innovations in Aluminikumn foil applications



ROBERT V NEHER AWARD
A Global Academic Competition

Presented at ALUMINIUM 2018, Düsseldorf - Germany

1) Runner-up :

“Aluminum-Magnesium-Silicon alloy foil for explosion blocking and suppression material“
by Jianguo Li, Liyuan Su - School of Materials Science & Engineering, Beijing/China

2) Winner :

“Development of Super Oil & Water Repellent Material”
by Hiroyuki Nishikawa / TOYAL LOTUS



„Aluminum-Magnesium-Silicon alloy foil for explosion blocking and suppression material“

by Jianguo Li, Liyuan Su - School of Materials Science & Engineering, Beijing/China



modified slit



3D structure

Fire-retardant & explosion-proof aluminum foil nets with modified inner and 3D (hexagonal) structure with improved compression performance



Oil tank truck



Air plane crash

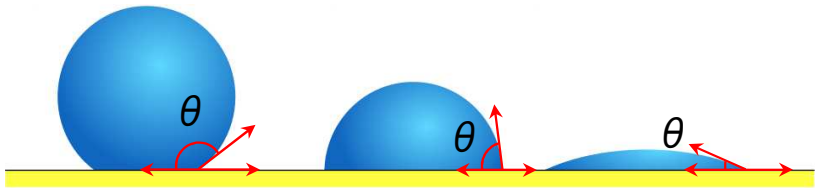
Explosion accidents

Water Repellent Effect of Lotus Leafs



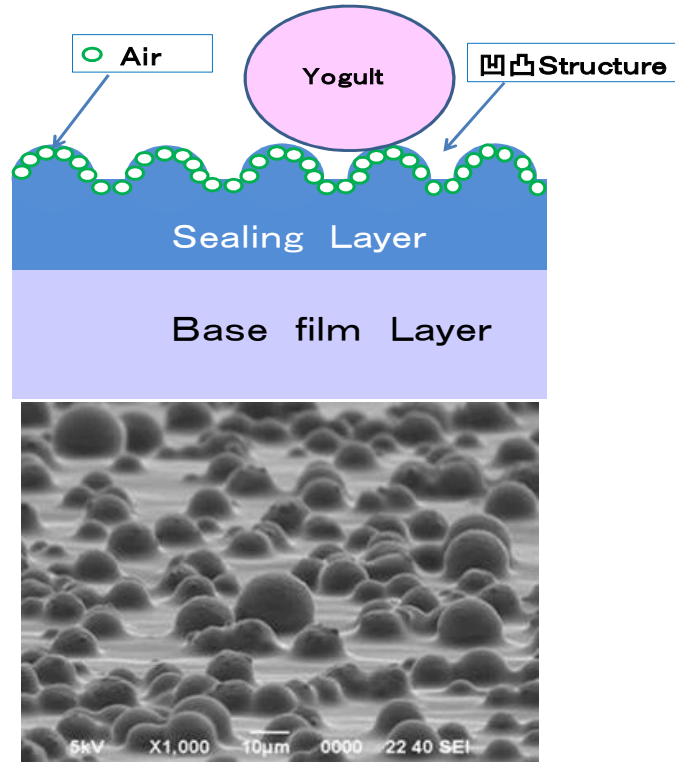
■ Lotus Effect

Lotus leafs show a very high water repellency because of the fine physical surface structure, called as a “**Lotus Effect**” **Contact angle $\geq 160^\circ$**



Super water repellent:
 $150^\circ \leq \theta$

An Image of the TOYAL LOTUS®



Magnified Surface of the TOYAL LOTUS

Super oil and water repellent foil surfaces



- Clean aluminium packaging material
- It's effective for Food loss reduction (SAVE FOOD)



- ① Super-oil-repellent material
- ② Low sticking with oily contents
- ③ Applicable to foods, medicines and industrial applications

Applications for the “TOYAL · ULTRA LOTUS ”

**Industrial
House Hold**

- **Materials to avoid oil sticking**
(Kitchen panels, Process papers, etc.)



Foods

- **Plastic cup for oily foods**
- **Pouches for oily foods**



**Medicines
Cosmetics**

- **Caps for cosmetic containers**

Robert V Neher Award Winner :

“Development of Super Oil &
Water Repellent Material”
by Hiroyuki Nishikawa

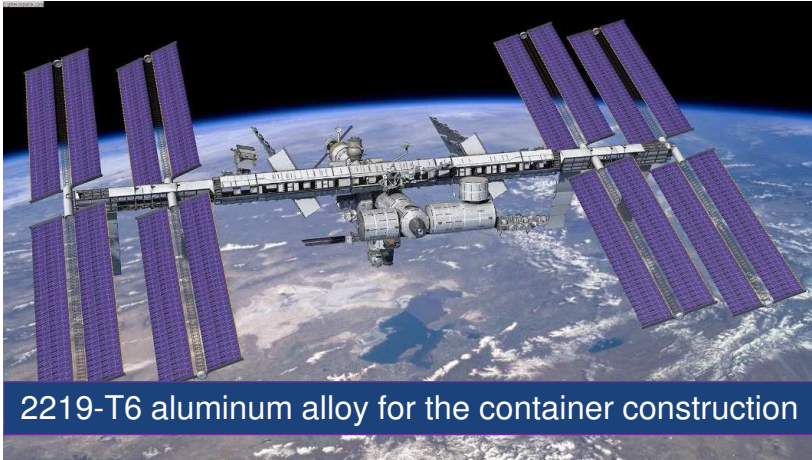


ROBERT V NEHER AWARD
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Aluminium foil in Space constructions



Aluminium innovations for futuristic fashion design



Ayse Byzanz / Düsseldorf : Aluminium foil fashion design, car and light decoration

Summary

- Aluminium is the most suitable metal for (extreme $<6\mu\text{m}!$) thin foil production and processing.

Its specific properties are relative high strength (alloy dependent : +Fe,Mn), good formability and low porosity (low penetration effects on the corrugated matt side in foil double rolling).

- Aluminium foil can be cold rolled to the extreme ($<6\mu\text{m}!$) and most efficiently, i.e. with extreme high speed (>2000 meters/minute!), including highly controlled surface effects and matt side

New foil alloys, besides pure Aluminium (99,5 1200) are Al-Fe (8011, 8079, u.ä..), Al-Fe-Mn (8xxx, 3xxx) can further refine these properties and are applied in classical applications :-

- Aluminium Foil for food packaging (lids, wrap, pharmacy blister, TetraPak antiseptic liquid package)

Recent innovations in Al-foil applications (awarded by the EAFA/GLAFRI «Robert V Neher» Award):

- “Aluminum-Magnesium-Silicon Alloys foil for explosion blocking and suppression material“ (China)

- “Super Oil and water Repellent Packaging Material “by Hiroyuki Nishikawa – TOYAL/Japan

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