

Namindo Pty Ltd

2026 EDITION

Polymers and Composites

Applications to society and the workplace, through science and technology

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First given at BINUS Education Foundation, Jakarta, November 2017; updated October 2026

Me, my society and my home

- 1 What am I here for?
- 2 What do I want to do?
- 3 What do I wish to contribute?
- 4 What do I wish to leave behind?
- 5 Whom do I wish to work with?

Why ask this in a materials talk?

Every phone, car, bridge and hospital bed is made of materials someone chose.

Engineers who choose well build a cleaner, safer society. These five questions were the opening of the 2017 talk. They matter more in 2026, as the world asks materials to be lighter, longer lasting and recyclable.

2017 then, 2026 now

2017

2026

World plastics production

335 Mt

in 2016



431 Mt

a year now

Longest wind turbine blade

88.4 m

LM Wind Power, 2016



153 m

Dongfang 26 MW, 2025

Global plastics treaty

Not on the agenda



Talks since 2022

no treaty yet

Source: PlasticsEurope, *Plastics the Facts 2017*; European Bioplastics, *Market Data 2025*; LM Wind Power 2016; offshoreWIND.biz, Jan 2026; IISD, Feb 2026

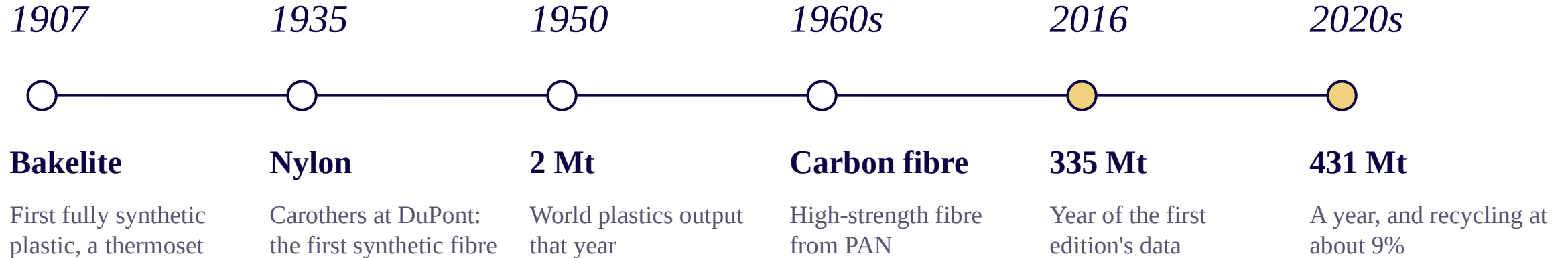
01

Where polymers came from

From horn and cellulose to 431 million tonnes a year

Moulded by many parts

Plastic comes from the Greek plastikos: able to be moulded. **Polymer** is Greek too: poly (many) and meros (parts). The first polymers people used were natural: cellulose, horn, rubber and silk.

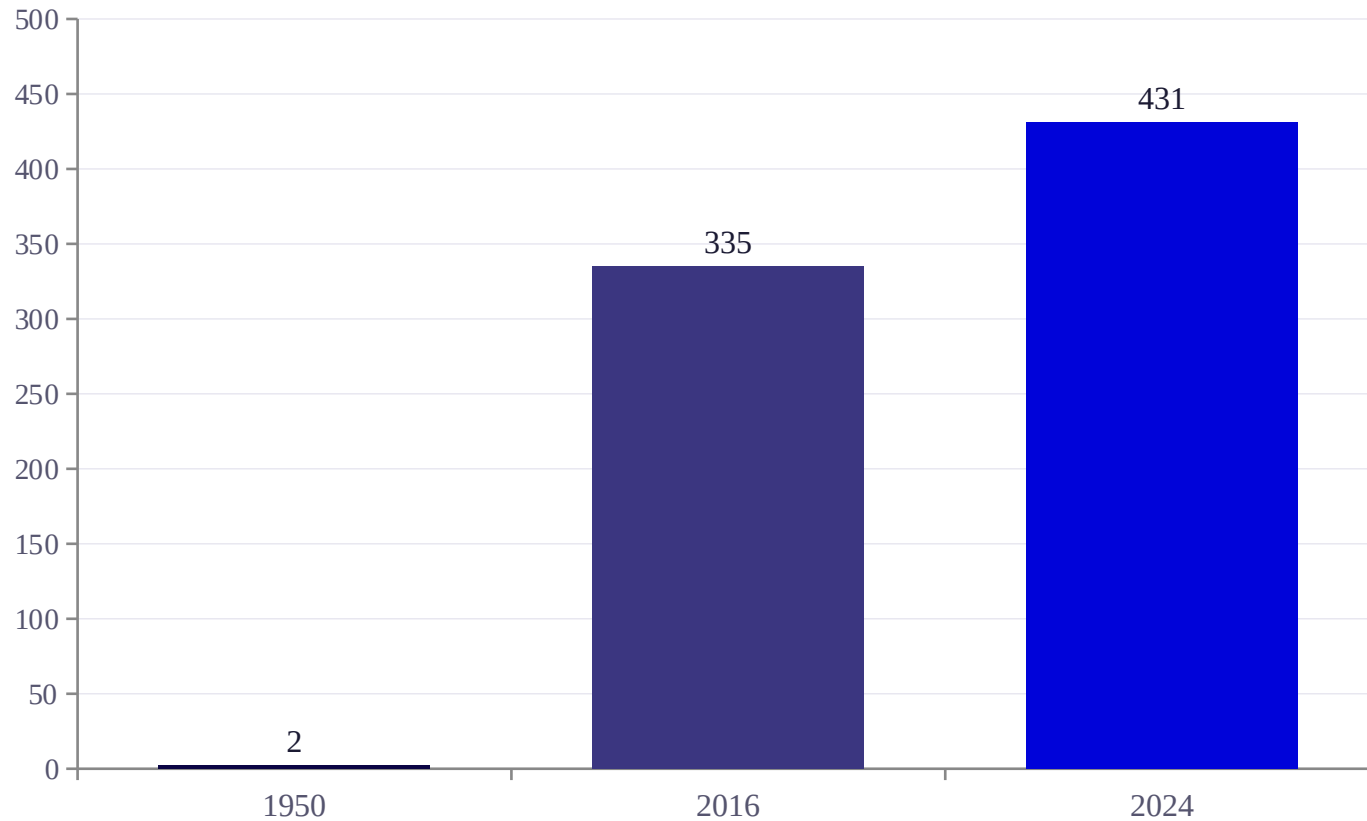


In the 1920s coal and oil became the raw materials for polymers. Ethylene was the first. That is still the base of most plastics today.

Source: Geyer et al., *Science Advances* 2017; *PlasticsEurope* 2017; *European Bioplastics* 2025; *OECD Global Plastics Outlook* 2022

Production has grown more than 200 times since 1950

World plastics production, million tonnes a year



9%

of plastic waste is recycled worldwide. The rest is burned, landfilled or leaks.

0.5%

of plastics are bio-based or biodegradable today.

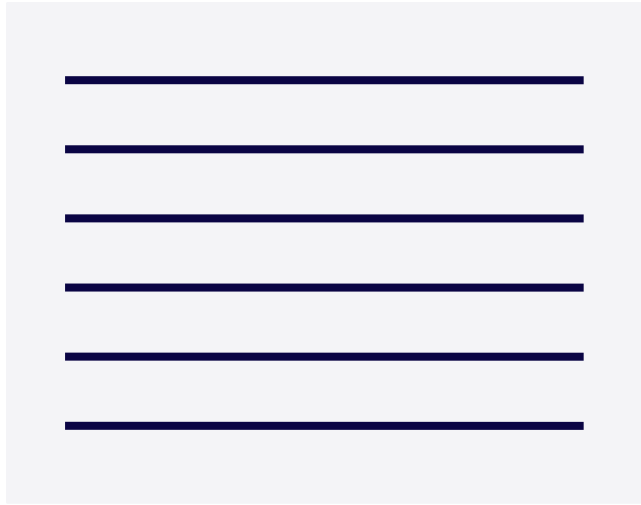
Source: Geyer et al. 2017 (1950); PlasticsEurope 2017 (2016); European Bioplastics, Dec 2025 (431 Mt, 0.5%); OECD 2022 (9%)

02

What a composite is

Strong fibres held in a tough matrix: materials designed for a job

Fibre plus matrix makes a designer material



Fibre

Carries the load. Glass, carbon, aramid or natural fibre.

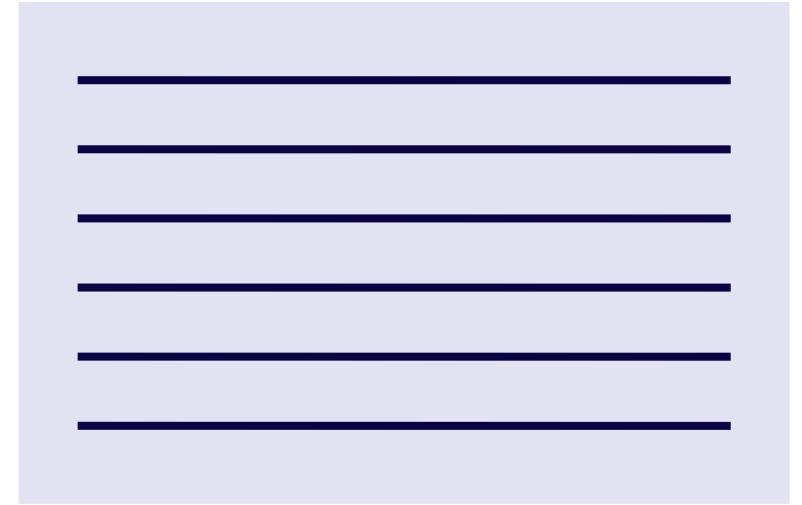
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Matrix

Holds fibres in place and shares load.
Epoxy, polyester, nylon, PEEK,
ceramic or metal.

=



Composite

Light, stiff and strong in the directions the designer chooses.

We now design the material and the part together. In 2017 we called this playing in the image of God. In 2026 software does much of the layup design, but the idea is the same.

Composites are older than writing



Chimú adobe fort, Paramonga, Peru, about 1300 AD



Bronze Age mud-brick arch, Tel Dan

Straw in mud is fibre in a matrix

- Builders in the Middle East, the Andes and the American Southwest mixed straw into clay bricks.
- The straw stops cracks from running. The clay carries compression.
- Steel rebar in concrete and carbon fibre in epoxy work the same way.

Source: Photos from the 2017 edition of this talk

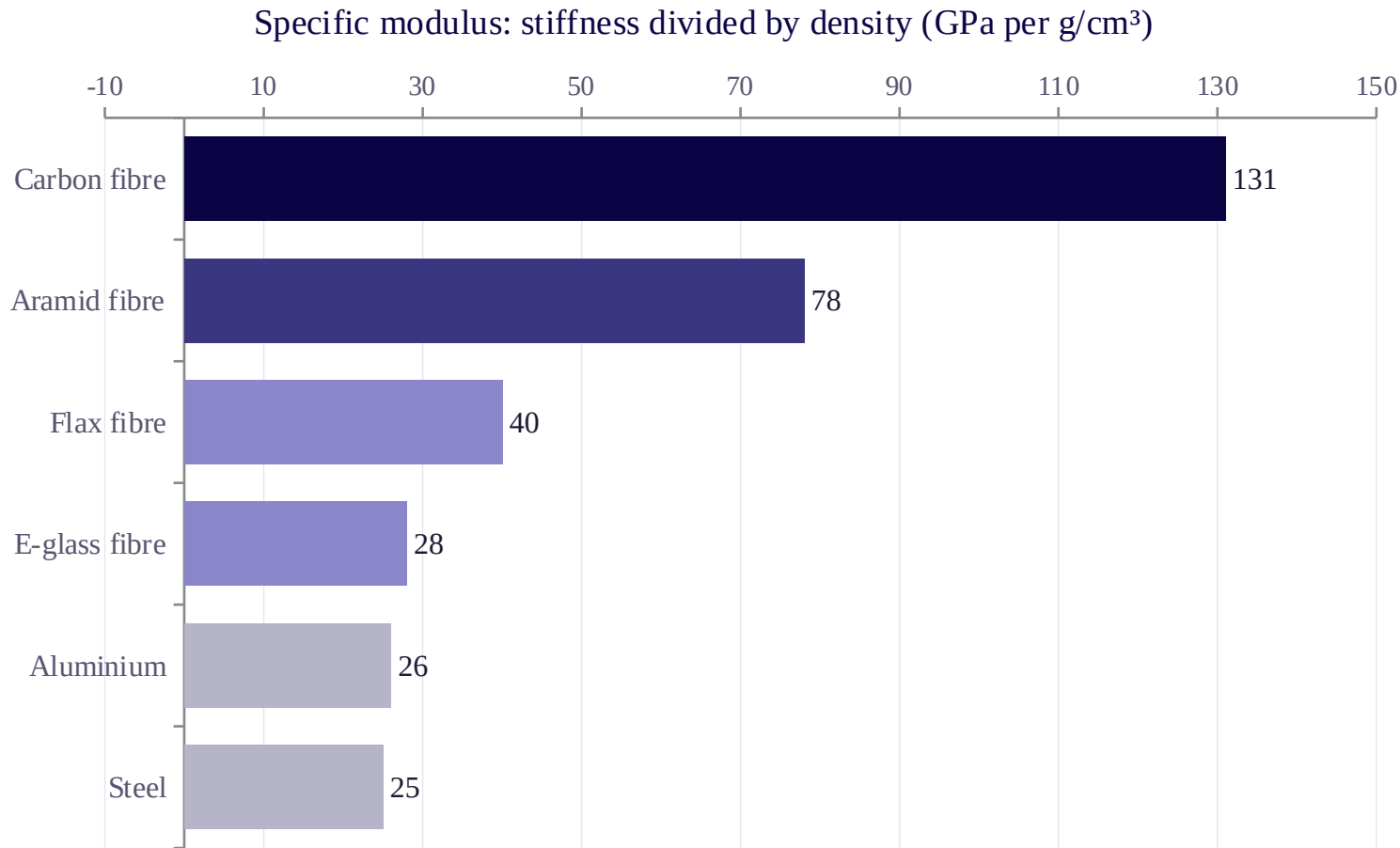
The fibres we choose from

Material	Tensile strength (GPa)	Stiffness, modulus (GPa)	Density (g/cm ³)	Typical use
E-glass fibre	3.4	72	2.58	Boats, pipes, wind blade shells
Carbon fibre, standard (T300 class)	3.5	230	1.76	Aircraft, wind spar caps, tanks
Aramid fibre (Kevlar 49 class)	3.6	112	1.44	Armour, ropes, hulls
Flax fibre	0.5 to 1.5	50 to 70	1.5	Car interiors, sports goods
Structural steel (for reference)	0.4 to 0.55	200	7.85	Buildings, bridges
Aluminium 6061 (for reference)	0.31	69	2.70	Car bodies, frames

Carbon fibre is as stiff as steel at less than a quarter of the weight.

Source: Typical published datasheet values: Toray T300, DuPont Kevlar 49, E-glass suppliers; ASM data for metals. Values vary by grade.

Stiffness for its weight is what matters

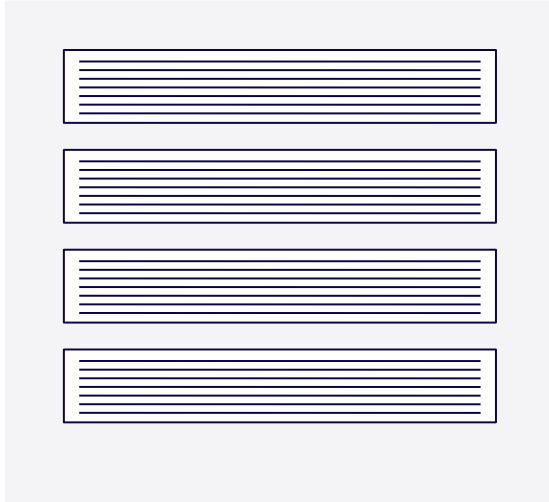


Why it matters

A lighter part saves fuel in a plane, extends the range of an electric car and lets a wind blade grow longer. The fibre sets the ceiling. The design decides how much of it you use.

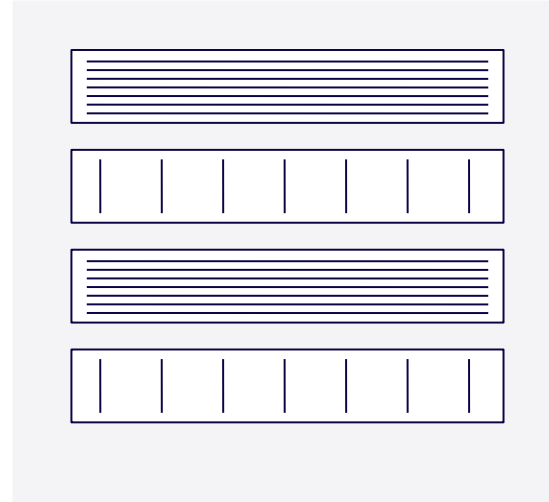
Source: Calculated from the typical values on the previous slide

Lay the fibres where the loads go



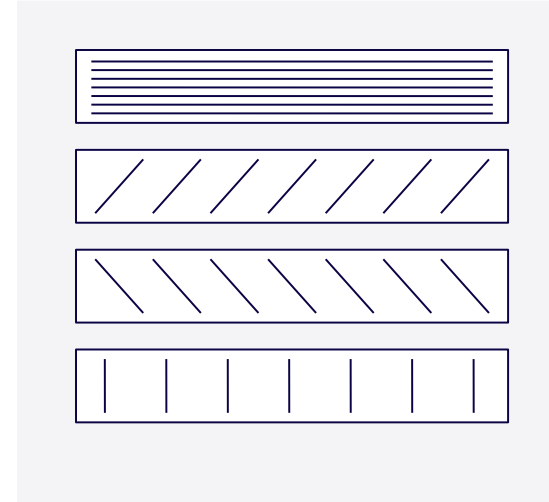
Unidirectional

All fibres at 0° . Very strong along the fibre, weak across it.



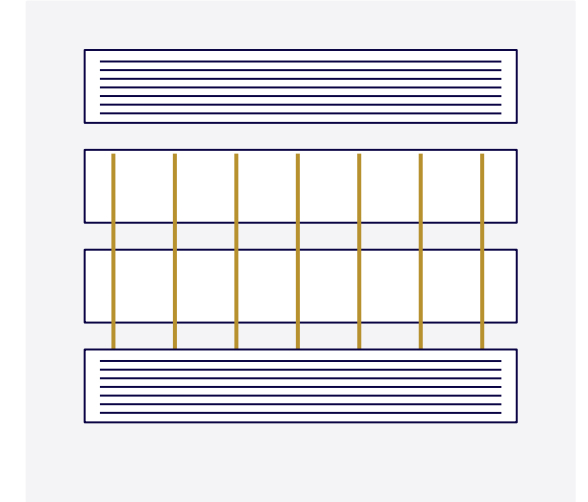
Cross-ply

Layers at 0° and 90° . Good in two directions.



Quasi-isotropic

0° , $+45^\circ$, -45° , 90° . Behaves much like a metal sheet in plane.



3D woven

Fibres also run through the thickness, so layers cannot peel apart.

Strength falls fast as the load turns away from the fibre direction. A glass-epoxy ply pulled at 90° to its fibres keeps only a small fraction of its 0° strength.

Source: Standard laminate design practice; fibre-angle data shown in the 2017 edition

Three ways to load a part



Tension

Pull it apart

Stress $\sigma = F / A$

Strain $\epsilon = \Delta L / L$

Modulus $E = \sigma / \epsilon$



Compression

Push it together

Same formulas, but fibres can buckle.
Composites are often weaker in compression than in tension.



Bending

Load it like a beam

Top face in compression, bottom in tension. Three-point bend test: flexural modulus $E = L^3m / (4bd^3)$

Source: F load, A area, L length, m slope of load against deflection, b width, d thickness

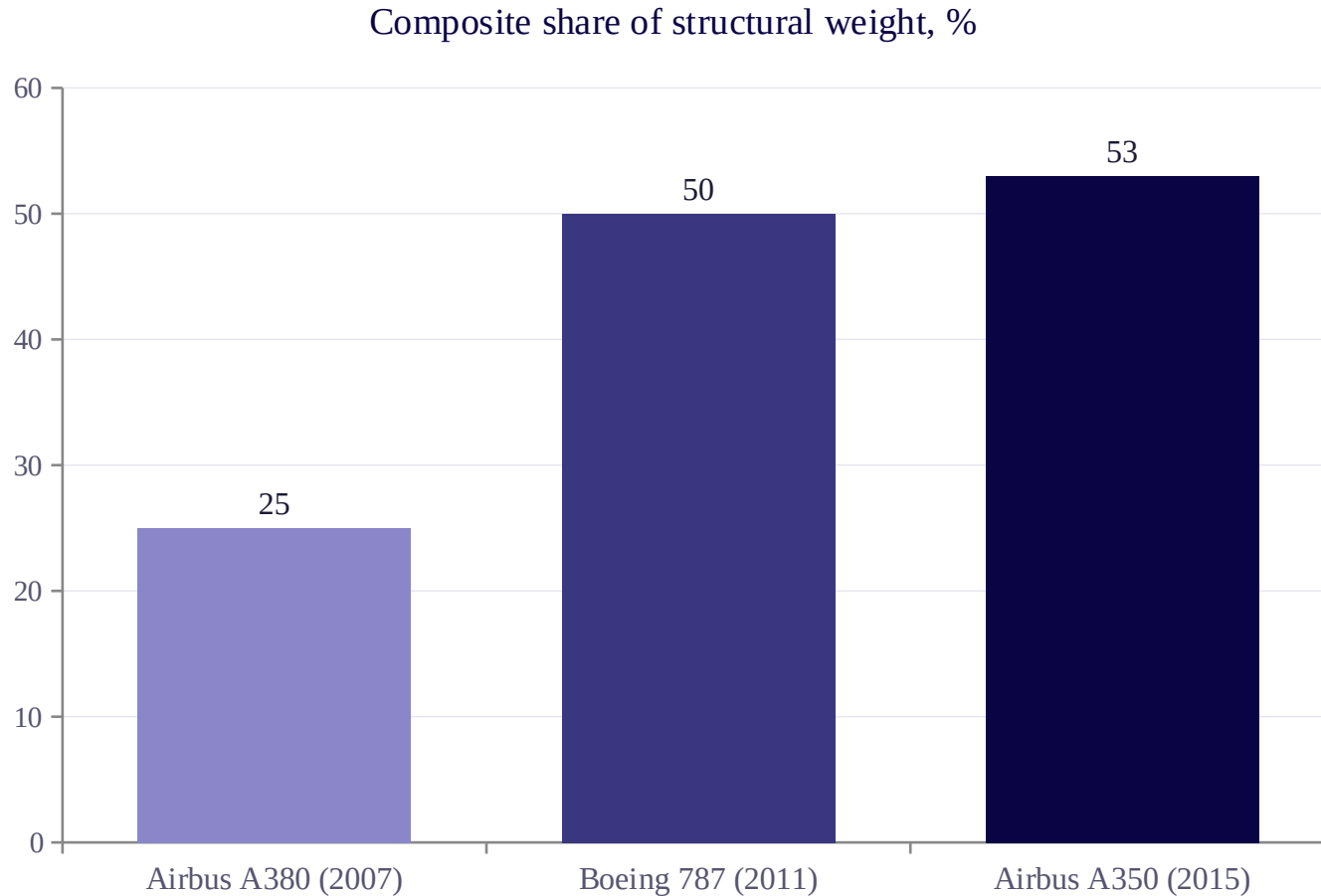
03

Composites at work in 2026

Planes, engines, wind, hydrogen, cars, medicine and buildings

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Half of a modern airliner is composite



What changed since 2017

- Whole fuselage barrels and wings in carbon fibre are now normal on long-haul jets.
- Lighter airframes cut fuel use and so cut emissions.
- Newer models add more carbon parts, such as door surrounds.
- Sustainable aviation fuel and light airframes now work together.

Source: Aviation Week, June 2020 (A380, A350); Boeing, 787 by design (787)

Ceramic composites moved from test stand to jet engine

1998: in the lab

- Woven SiC fibre in a SiC matrix (SiC/SiC).
- An exhaust tail-cone ran at a gas temperature of 1,573 K.
- A braided thrust chamber was hot-fired at 2,073 K.
- Carbon/carbon was already used on re-entry nose cones and leading edges.



2016 onward: in service

- Ceramic matrix composite shrouds fly in the hot section of the CFM LEAP engine, in service since 2016.
- CMC parts weigh about a third as much as the nickel alloys they replace and need less cooling air.

Source: 2017 edition (test data, 1998); GE Aerospace and CFM International public material on LEAP CMC shrouds

Wind is now the biggest user of carbon fibre

44.5%

of world carbon fibre demand went into wind blades in 2025, the first time wind passed that mark.

153 m

blade on the Dongfang 26 MW turbine, installed for testing in 2025. Rotor 310 m across.

88.4 m

was the record blade in 2016, a year before the first edition. Blades are 70% longer in under ten years.

Long blades need stiff, light spar caps. That is carbon fibre's job.

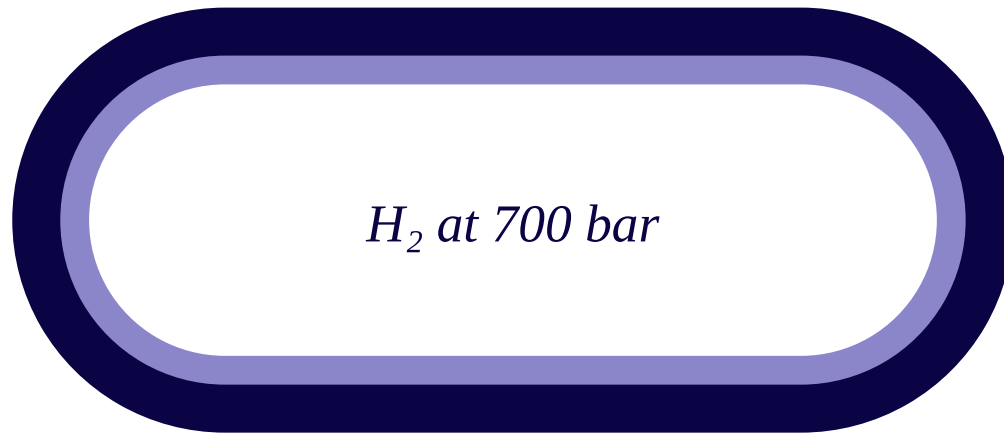
Source: ATA Global Carbon Fiber Composites Market Report 2025, via CompositesWorld, June 2026; offshoreWIND.biz, Jan 2026; LM Wind Power 2016

What happens to a blade after 20 years



Source: Canary Media, Feb 2023 (Vestas; Siemens Gamesa RecyclableBlade at Kaskasi)

Hydrogen travels in plastic wrapped in carbon fibre



Carbon fibre wrap

Polymer liner (polyamide)

72.7 kg

of composite holds 5.6 kg of usable hydrogen in a car-size 700 bar system.

≈ 55%

of the system cost is the carbon fibre composite.

Type IV tanks, used in cars such as the Toyota Mirai, carry no metal in the wall. Cheaper carbon fibre is the biggest lever on hydrogen storage cost. Storage at scale is also the moonshot in Namindo's own technology work.

Source: US DOE Hydrogen Program Record 24006, April 2025; PlasticsToday on the Mirai tank liner

Cars: lighter, greener and electric

In the 2017 edition

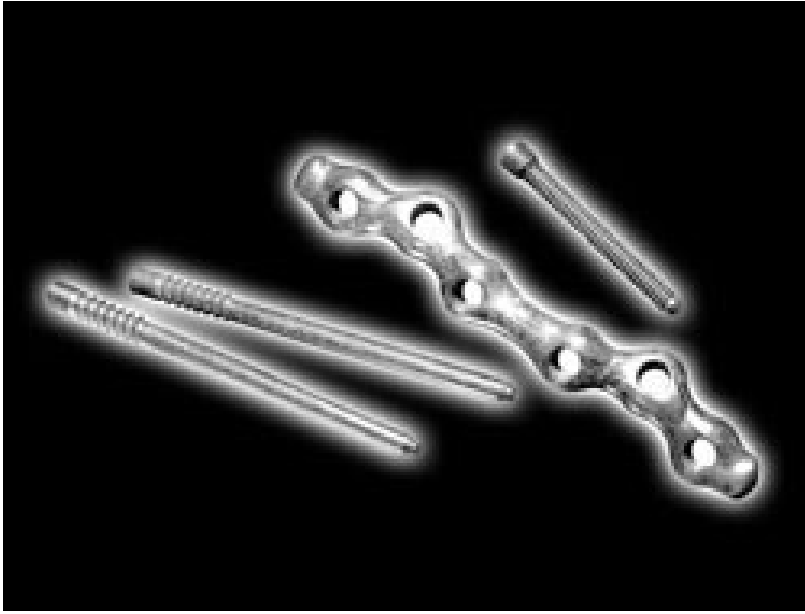
- Banana fibre underbody trim on the Mercedes A-Class.
- Wood and bio-fibre door panels and instrument panels.
- Glass fibre bodies on classic sports cars such as the Ferrari 308 GT4.

In 2026

- Battery packs are heavy, so every kilogram saved elsewhere adds range.
- Several carmakers now use composite and polymer battery covers and trays.
- Hydrogen cars and trucks carry carbon fibre tanks.
- Natural fibres such as flax and kenaf grow in Asia, including Indonesia, and suit interior parts.

Source: 2017 edition (DaimlerChrysler; Bledzki et al. 2006); general industry practice 2026

Composites inside the human body



Bone plates and pins moulded in carbon fibre reinforced PEEK

Carbon fibre PEEK implants

Plates, nails and spine cages. Stiffness closer to bone than titanium, and they do not block X-ray or MRI, so doctors can see the bone heal.

Dental composites

Resin filled with fine glass particles. Research continues on longer life, such as thiourethane additives.

Joint replacements

Hips and knees use tough polymers such as cross-linked UHMWPE for the bearing surface.

Buildings and infrastructure



Pultruded glass fibre rods and profiles

Glass fibre rebar

Does not rust. Useful in coastal cities, seawalls and chemical plants, where steel corrodes.

Pultruded profiles

Cable ladders, handrails, gratings, telecom rods and antenna covers. Light and long-lasting.

Wood-plastic composites

Wood flour in polypropylene for decking and fencing. Die-drawing makes it stronger than the wood it replaces.

Strengthening old structures

Carbon fibre sheets bonded to beams and columns add strength without heavy steel.

Carbon fibre in numbers, 2025

150–225 kt

of carbon fibre used worldwide in 2025. Two leading surveys disagree on the size. Both show strong growth.

\$30 billion

in carbon fibre composite sales in 2025, up 16% in a year.

10.6%

average yearly growth in carbon fibre demand since 2010.

Wind uses the most fibre. Aerospace pays the most for it: 44% of fibre revenue.

Source: Composites United Market Report 2025 (148.5 kt; 10.55% CAGR 2010 to 2025); ATA report 2025 via CompositesWorld, June 2026 (224.5 kt; USD 30.35 billion)

04

Circular and bio-based

Plastics that come back, and plastics that grow

Only one tenth of plastic is recycled

World

9%

of plastic waste is recycled. Half goes to landfill and a fifth is mismanaged.

Indonesia

6.8 Mt

of plastic waste a year, growing about 5% a year. About 10% is recycled and 70% is mismanaged.

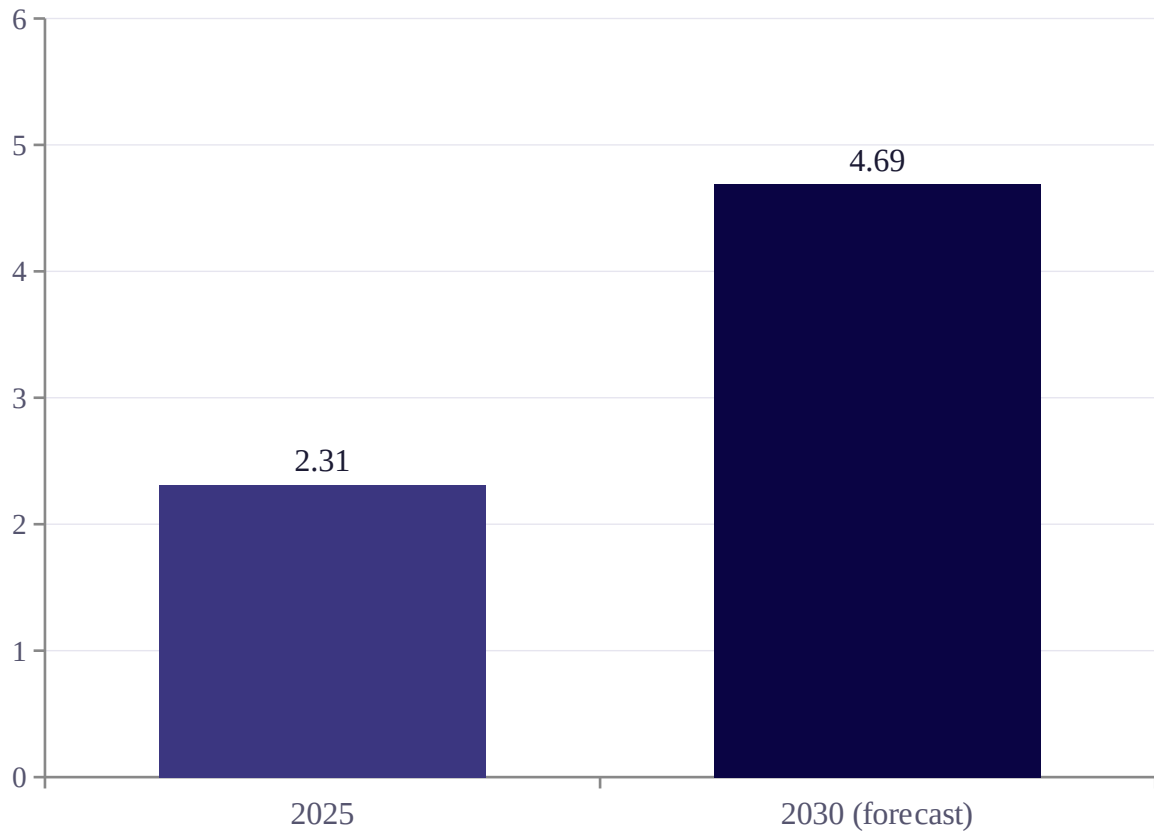
The treaty

Countries began a global plastics treaty in 2022. Talks in Geneva in August 2025 ended without agreement. A new chair from Chile was elected in February 2026, and the next round is planned for late 2026 or early 2027.

Source: OECD Global Plastics Outlook 2022; Indonesia NPAP Action Plan 2020 (2017 data); IISD, Feb 2026; Felix Dodds blog, Mar 2026

Bioplastics will double by 2030, from a small base

Global bioplastics production capacity, million tonnes



PLA and PHA lead the way

- PLA (polylactic acid) is made from plant sugars and is used for packaging, fibres and 3D printing.
- PHA is made by bacteria and breaks down in soil and sea water.
- Even doubled, bioplastics stay near 1% of all plastics. Recycling still has to do most of the work.
- I worked on PLA and PHA biodegradable fibres at Indorama in the 1990s. The chemistry was ready long before the market.

Source: *European Bioplastics, Market Data 2025, Dec 2025*

05

Your career, and ours

Where materials work is going, and where Namindo has been

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Careers in materials, 2026 and beyond

Energy materials

Hydrogen tanks, wind blades, solar encapsulants and battery enclosures.

Circular economy

Recycling plastics and composites, and designing parts to come apart at end of life.

Bio-based materials

PLA, PHA and natural fibres from Indonesian crops and residues.

Digital materials

Simulation, process data and AI that help find and test new materials faster.

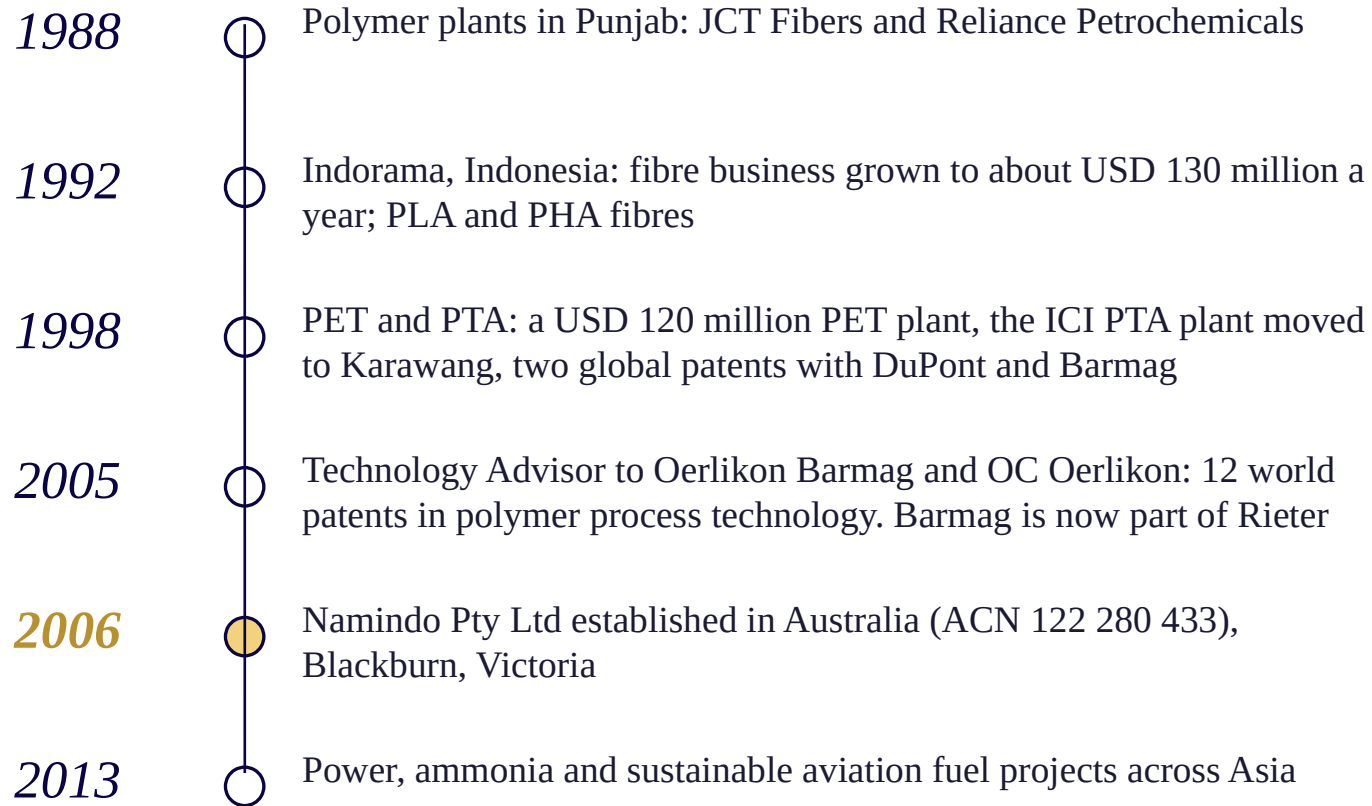
Advanced manufacturing

Automated fibre placement, pultrusion and 3D printing of composites.

Skills that last

Chemistry and mechanics, plus the habit of asking what happens to a product after use.

Namindo since 2006

- 
- A vertical timeline on the left side of the slide, with a central vertical line and circles at each year. The year 2006 is highlighted in gold. The text to the right of the line is in a dark blue serif font.
- 1988 Polymer plants in Punjab: JCT Fibers and Reliance Petrochemicals
 - 1992 Indorama, Indonesia: fibre business grown to about USD 130 million a year; PLA and PHA fibres
 - 1998 PET and PTA: a USD 120 million PET plant, the ICI PTA plant moved to Karawang, two global patents with DuPont and Barmag
 - 2005 Technology Advisor to Oerlikon Barmag and OC Oerlikon: 12 world patents in polymer process technology. Barmag is now part of Rieter
 - 2006 Namindo Pty Ltd established in Australia (ACN 122 280 433), Blackburn, Victoria
 - 2013 Power, ammonia and sustainable aviation fuel projects across Asia

Namindo today

- Owner's engineering for energy and process plants
- Polymers and materials practice
- Bifacial solar yield programme
- Hydrogen storage, our moonshot
- Sonic reactors for process work

Founder: Suprit Pal Singh, B.Tech in Polymeric Fibres and Process Technologies

Sources

- PlasticsEurope, Plastics the Facts 2017 (335 Mt in 2016)
- European Bioplastics, Market Data 2025, press release 2 Dec 2025 (2.31 Mt, 4.69 Mt, 431 Mt, 0.5%)
- Geyer, Jambeck and Law, Production, use and fate of all plastics ever made, Science Advances, 2017
- OECD, Global Plastics Outlook, press release Feb 2022 (9% recycled)
- Indonesia National Plastic Action Partnership, Multistakeholder Action Plan, April 2020
- IISD, INC-5.3 explainer, Feb 2026; Felix Dodds, Plastics negotiations update, Mar 2026
- ATA Global Carbon Fiber Composites Market Report 2025, CompositesWorld, 22 June 2026
- Composites United, Market Report 2025 (short version), March 2026
- offshoreWIND.biz, Offshore wind turbines in 2025, 1 Jan 2026 (Dongfang 26 MW, 153 m blade)
- LM Wind Power, 88.4 m blade, 2016
- Canary Media, Vestas has a new way to keep blades out of the dump, Feb 2023
- Aviation Week, Have the 787 and A350 set the standard for composites?, June 2020; Boeing, 787 by design
- US DOE Hydrogen Program Record 24006, Onboard storage cost and performance, April 2025
- Typical fibre datasheets: Toray T300, DuPont Kevlar 49, E-glass; ASM data for metals
- Images: from the 2017 edition of this talk



What do you wish to leave behind?

Thank you

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