Answers

Answer 1 - Composite materials are special. True or False ?

- They are heterogeneous – True

They are made of different components (resin + reinforcement)

- They are anisotropic – True

Depending on the components, their properties differ according to the direction and stress.

- They do not follow Hoocke's law – True

Due to their heterogeneity, the composites do not follow Hoocke's law (constraint = function of deformation). Evaluating their resistance through calculation is thus made rather difficult.

- They do not exist as such and are produced depending on the needs – True

That's the great advantage of composites : we produce as much material as we need while optimizing the Weight-Resistance relationship to its best !

Lien à prévoir vers la vidéo de la définition d'un composite

Answer 2 - Composite materials are made up in two parts. What type of resin do we usually find in thermoset composites ?

- Unsaturated polyester (Yes, it is the basic resin for mass-produced composites. Its symbol is UP – Unsaturated Polyester)
- Polypropylene (No, it's a thermoplastic)
- Polyethylene (No, it's a thermoplastic)
- Epoxy (Yes, it is the basic resin for technical composites. Its symbol is EP)
- Polyamide (No, it's a thermoplastic)
- Saturated polyester (No, it's a thermoplastic. We produce, for example, bottles with it)

And what type of reinforcement

- Glass (Yes)
- Carbon (Yes)
- Kevlar (Yes)
- Boron (Yes)

Answer 3

Fiberglass is produced by spinning through a capillary at a temperature of 1200°C. Silica reaches its melting point at 1700°C, but no material is resistant enough at this temperature to build the capillary. For that matter, Silica is combined with other elements to lower its melting point.

Answer 4 - We saw that there are several types of fiberglass, more particularly the E-glass and R-glass : True or False ?

- E-glass has been developed for its electrical properties. - True
- E-glass has a much lower density than aluminum. - False
  It is slightly equal to the density of aluminum.
- E-glass is a Young's modulus equivalent to aluminum. - True
- The R in R-glass stands for « Resistant ». - True
- R-glass is used for its mechanical properties. - True
- There is a C-glass resisting to corrosion. - True
  C-Glass resists well to corrosion in an acid environment and there is also a D-Glass that has been developed for dielectric purposes.

Answer 5 - Carbon fibers : production. True or False ?

- Newton made the first carbon fibers from bamboo. - False
  Edison did, in 1901, with cellulose that was exctracted from bamboo.
- Carbon fiber is mostly PAN-based. - True
  Most carbon fibers are produced by Polyacrylonitrile pyrolysis.
- Carbon fibers are made at a temperature of 2000°C. - False
  In most cases, it does not go beyond 1000°C.
- We can make carbon fibers from charcoal tar. - True
  The transformation is costly, with coal pitch, but we obtain high modulus fibers (900Gpa, which is four and a half times the modulus of steel)
- We can make carbon fibers with a modulus up to three times the modulus of steel. - False
  Four and a half !

Answer 6 - We use organic fibers for the reinforcement of thermosetting matrix composites from :

- Polyamide 11 (No)
- Polyethylene terephtalate (Yes)
- Polycarbonate (No)
- Polyphenilene sulfide (No) It is used as a matrix for high resistance thermoplastics)
- Polypropylene (No)
- Polyamide 6 (Yes)
- Polyphenylene terephtalamide (Yes) It is commonly known as Kevlar.
- Polyethylene (Yes) There are fibers called Dyneema, from the DSM company, made from a high modulus PE, with remarkable properties – modulus, density – but are not used at temperatures higher than 100°C.

Answer 7 - Advantages of Kevlar :

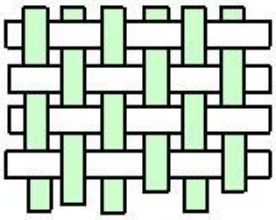
- The properties of Kevlar are isotropic. (False) Kevlar is anisotropic. It is resistant in fibre direction.
- Kevlar is generally used alone in a structure. (False) Due to its anisotropy.
- Kevlar is very difficult to cut out. (True) Due to its plastic deformation.

Answer 8 - Reinforcements are shaped and usually woven.

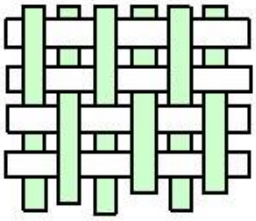
Canvas or Taffeta : Each warp yarn does under and over each weft yarn and conversely. The fabric presents a good planarity as well as a rather good rigidity, but it is barely deformable for the implementation. The numerous meshings create an important shrinkage and reduce mechanical properties.

Twill : Each warp yarn lies over several (n) weft yarn and each weft yarn lies over (m) warp yarn. The armor is more flexible than taffeta giving the yarn density. Here opposite, a 2/2 twill.

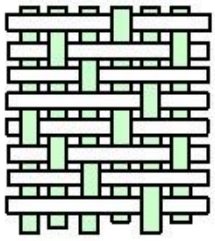
Satin: Each warp yarn lies over several (n-1) weft yarn and conversely. These fabrics look different on each side. They are rather flexible and adapted to the shaping of pieces with a complex surface. This type of fabric own a strong specific mass.



- **Toile ou taffetas :** Chaque fil de chaîne passe dessus puis dessous chaque fil de trame, et réciproquement. Le tissus présente une bonne planéité et une relative rigidité, mais est peu déformable pour la mise en œuvre. Les nombreux entrecroisements successifs génèrent un embuvage important et réduisent les propriétés mécaniques.



- **Serge :** Chaque fil de chaîne flotte au dessus de plusieurs (n) fils de trame et chaque fil de trame flotte au dessus de (m) fils de chaîne. Armure de plus grande souplesse que le taffetas ayant une bonne densité de fils. Ci-contre, un sergé 2/2.



- **Satin :** Chaque fil de chaîne flotte au dessus de plusieurs (n-1) fils de trame et réciproquement. Ces tissus ont des aspects différents de chaque côté. Ces tissus sont assez souples et adaptés à la mise en forme de pièces à surfaces complexes. Ce type de tissus présente une forte masse spécifique.

Answer 9 - Thermoplastic materials are classified in two main groups : Thermoplastics and Thermosets.

- Thermosets softens at the beginning of their transformation. (Yes)
- Thermoplastics melt when heated. (Yes) If their internal structure is semi-crystalline.
- Thermoplastics soften when heated. (Yes) Especially when their structure is amorphous.
- Thermosets melt when heated. (No) They disintegrate. They are not recyclable.
- Thermosets set when heated. (Yes) Or with hardeners or chemical catalyst.

Definitions :

- Thermoset Resin : polymer transformed into a product that is essentially infusible and insoluble after a thermic (heat, radiation) or physicochemical (catalyst, hardener) treatment.

- Thermoplastic Resin : polymere capable of being alternatively softened by heat and solidified by cold in a specific range of temperature specific to the polymer at issue. When softened, thermoplastics can be easily removed from the mold, due to plasiticity.

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Answer 10- The resins that are mostly used for mass-produced composites are UP-based (Unsaturated Polyester)

We use these resins with the following implementation techniques :

- Contact molding
- Simultaneous projection
- Vacuum molding
- Infusion

For the resin to set, it requires : (Yes or No)

- Cobalt octane (Yes and No)

It is an accelerator. Used at 0,2 %, it allows a faster hardening.We find pre-accelerated resins in which case this product would be useless. These resins do not preserve as well as the others but provides with less manipulations to do (no accelerator) which leads to a better safety.

- Acetone (No)

It is a solvent that aloows to clean up the tools.

- Heat (Yes and No)

It is not necessary but it accelerates the process as well as the hardening quality.

- Pressure (No)

- MEKP (Yes) - Methylethyketone Peroxyde

This catalyst is used the most with this type of resin. We use it from 0,5 % to 2,5 % according to the type of resin, desired gel time, temperature and hygrometry.

Answer 11 - Safety in the implementation of composites.

Accelerator – catalyst – polyester, epoxy , acetone ! All these products are dangerous for the user and the environment. Pictograms are depicted on their containers.