

Recycling of composite materials

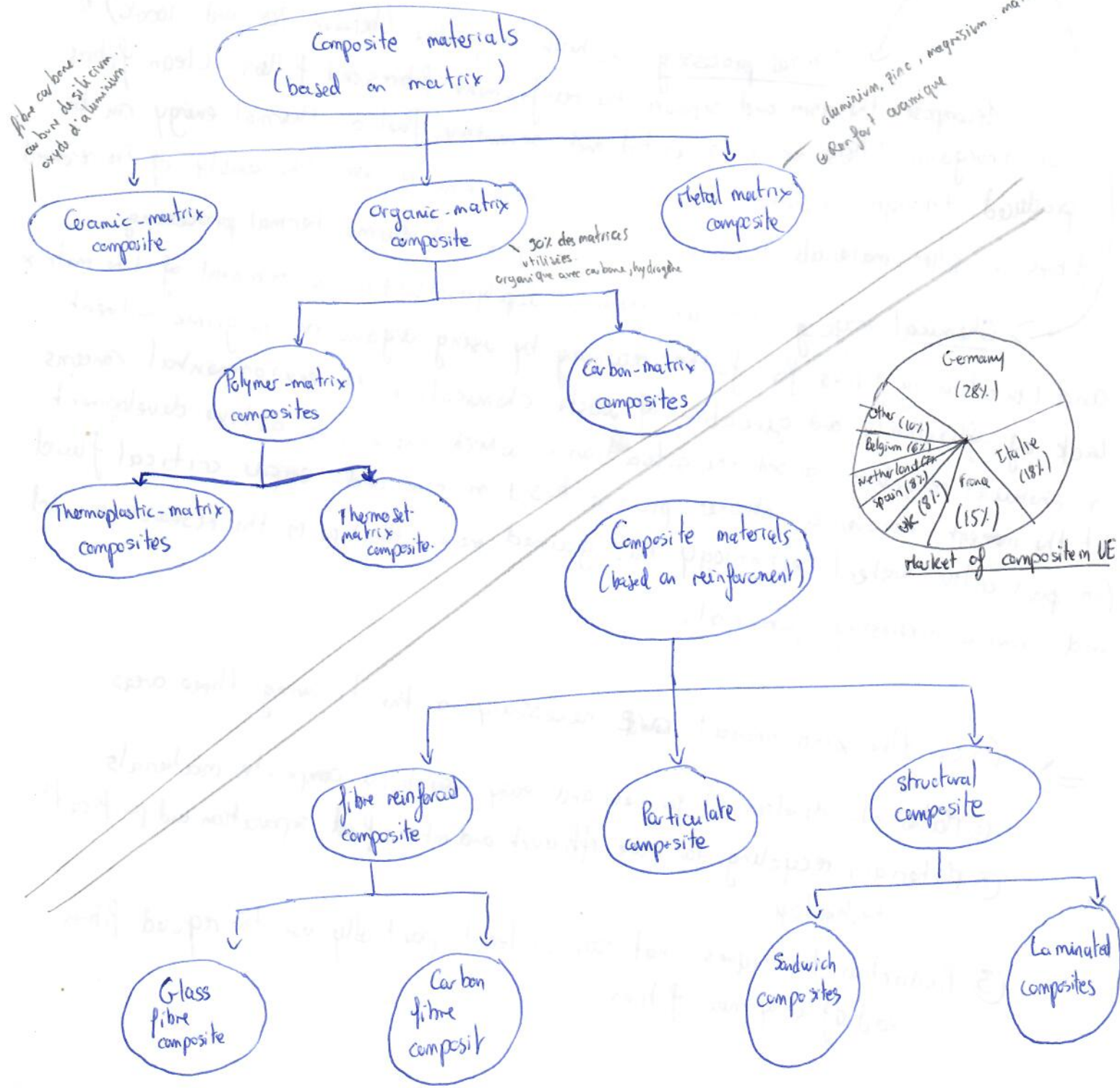
Introduction

PMC: polymer-matrix composite
 MMC: metal-matrix composite
 CMC: Ceramic-matrix composite

types of composites

classified into

- particulate composites.
- fibre-reinforced composites.
- structural composites



Nowadays metal
glass
thermal plastic } are recycled to a great extent

But composite materials are not (both for matrix and for the reinforcement materials)

↳ due to their inherent heterogeneous nature of the matrix and the reinforcement.

↳ in particular thermoset-based composites

⇒ Mechanical recycling: involves shredding and grinding followed by screening to separate fibre-rich and resin-rich fractions for re-use. The method is very energy intensive and the recycles have relatively low quality

⇒ Thermal processing: uses high temperature (between 300 and 1000°C) to decompose the resin and separate the reinforcement fibres and fillers. Clean fibres or inorganic fillers are re-generated and secondary fuel or thermal energy can be produced through pyrolysis, gasification or combustion. However the quality of the recovered fibres or filler materials degrades to a varying extent during thermal processing.

⇒ Chemical recycling: aims at chemical depolymerisation or removal of the matrix and liberation of fibres for further recycling by using organic or inorganic solvent.

Lack of flexibility and generation of waste chemicals with environmental concerns in chemical recycling caused the situation in which there is no active development at the moment. However a cleaner process based on near-and-super critical fluid (in particular water) technology has gained more attention in the research world and shown an interesting potential.

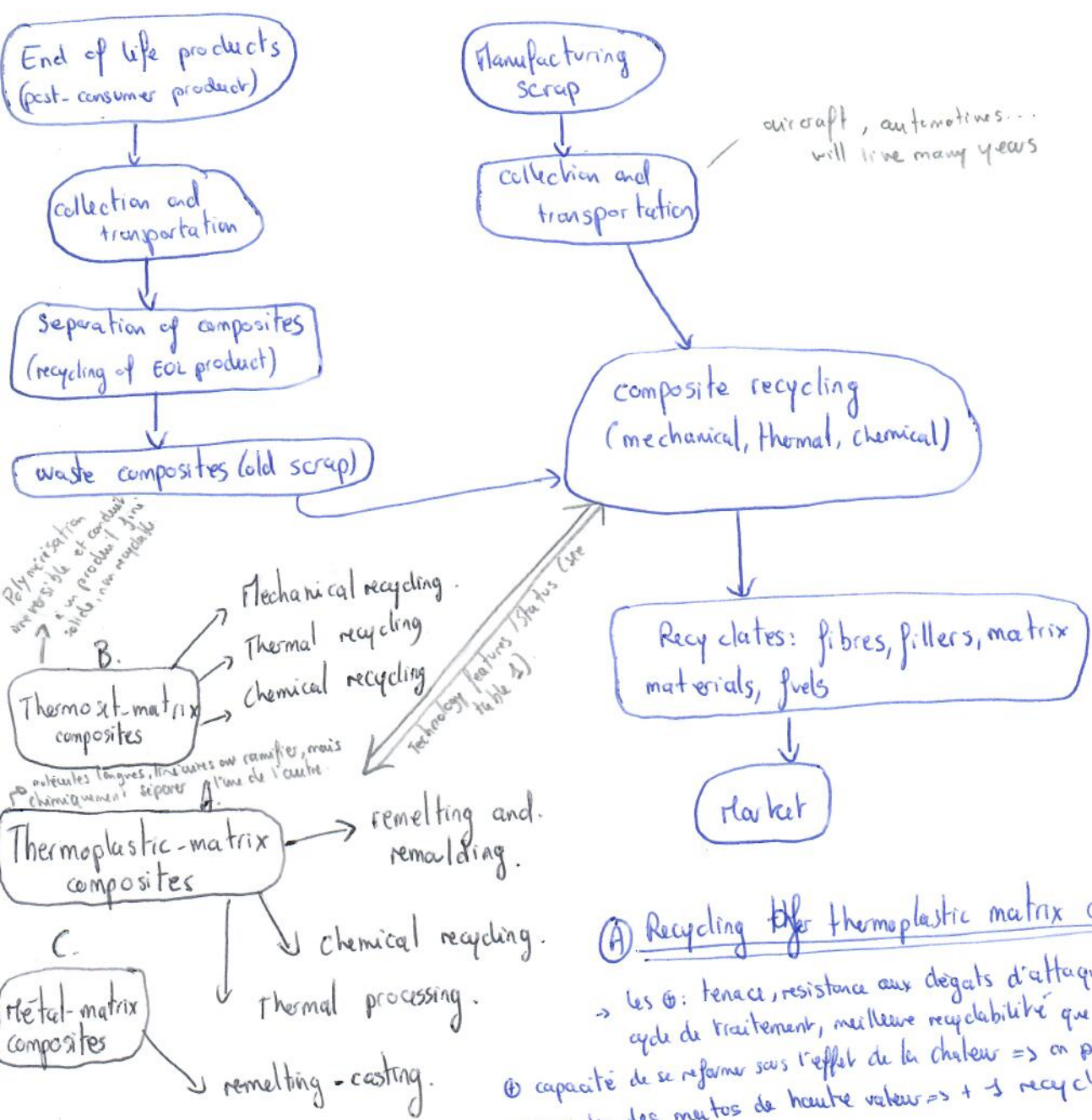
⇒ Groundbreaking innovation ~~and~~ necessary in the following three areas:

- ① Materials development for new and easy recyclable composite materials
- ② Materials recycling for more efficient and intensified separation and purification technologies.
- ③ Production techniques that can at least partially use the recycled fibres instead of only new fibres.

2. Overview of recycling technologies for composite materials

- Very limited industrial operations can be found for recycling of composite materials.
- Stronger environmental legislations ⇒ lot of techno have been developed

↳ General recycling systems.



A) Recycling of thermoplastic matrix composites.

- ↳ les @: tenace, resistance aux degats d'attaques chimiques, + rapide cycle de traitement, meilleure recyclabilite que les thermoset.
- ↳ capacite de se reformer sous l'effet de la chaleur ⇒ on peut chauffer et remouler des matos de haute valeur ⇒ + ↗ recyclage

→ Qd on decompose mecaniquement en grain ⇒ dévalue de matériel propriétés ⇒ ↓ de la force de traction, module de Young mais ↗ les échec de soude, et la résistance à la moisissure. - on y reviendra plus tard avec les composites avec polymères et thermoplastiques.

• Difficulté : haute viscosité de la masse fondue ⇒ besoin de forte pression ⇒ produits coûteux et forte consommation d'énergie entre le chauffage et le refroidissement.

↳ mais bon comme d'habitude. ya le PTFE on peut faire des de l'eau et ça évite la viscosité.

↳ otway (47) démontre la recyclabilité de composite thermoplastique des bateaux (A tchky les détails) p. 4.

⑧ Recycling Thermoset matrix composites → beaucoup de recherche là-dessus 10mm → 10µm

↳ Mechanical recycling: Réductⁿ de la taille par écrasement ou smashing puis classé selon riche en fibre / riche en matrice.



Recycling of thermoset matrix composites

Thermoset matrix composites are composed of a thermoset matrix and fibers. The recycling process involves breaking down the composite into fibers and matrix. The fibers can be recycled or non-recycled, and the matrix can be recycled or non-recycled. The recycled fibers and matrix can be used to produce new thermoset matrix composites.

The recycling process is complex and involves many steps. It is important to understand the different types of fibers and matrices used in thermoset matrix composites and how they are recycled. This will help to improve the recycling process and reduce the environmental impact of thermoset matrix composites.