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(54) Titre : COMPOSITE HYBRIDE
(54) Title: HYBRID COMPOSITE

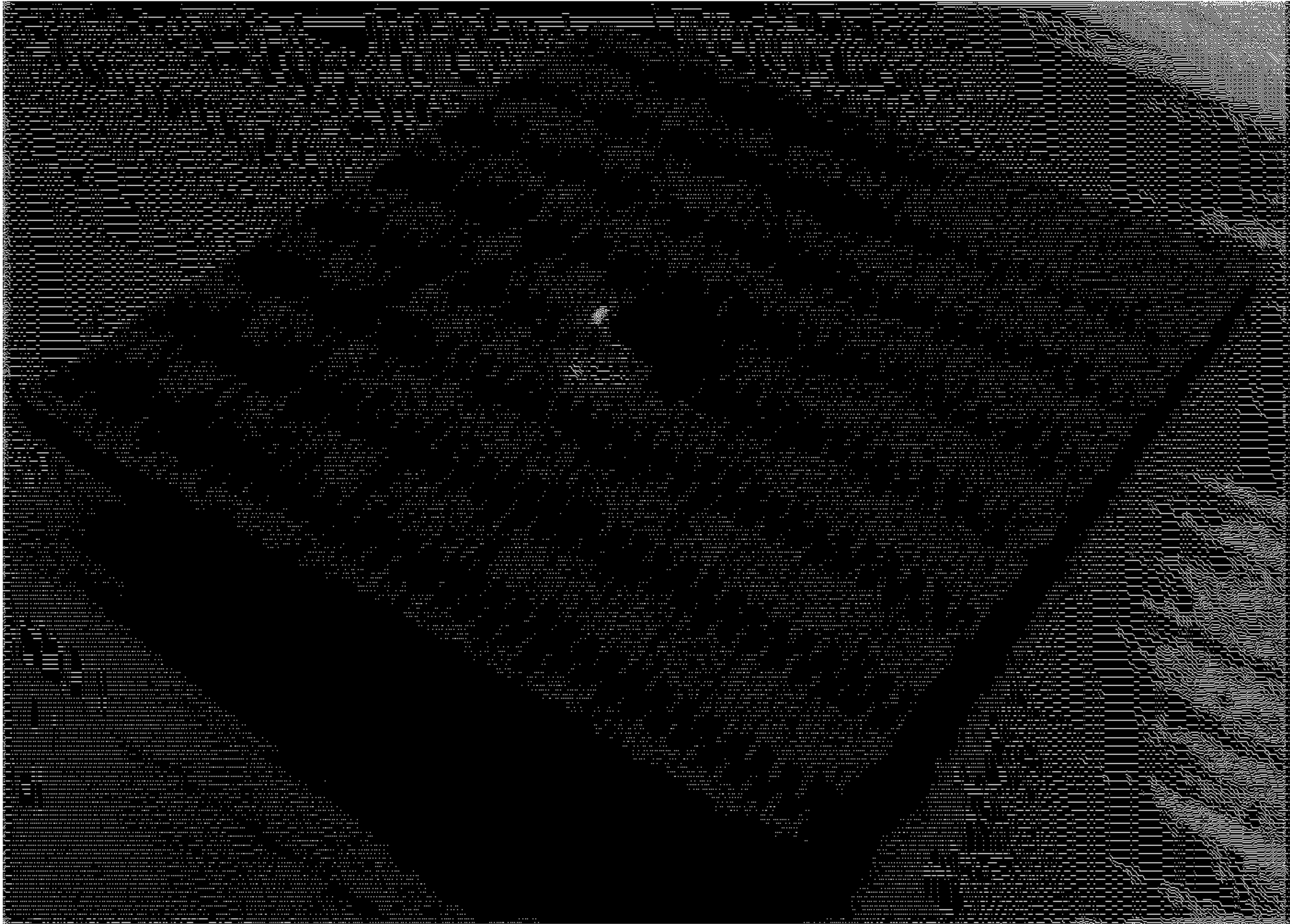


FIG. 20

(57) **Abrégé/Abstract:**
A hybrid composite comprising a thermoplastic or thermoset matrix in which brittle and ductile fibers (1) are present, characterized in that the fibers are configured such that the ductile fibers (1) of the hybrid composite dissipate energy at a impact or overload by plastic deformation of the ductile fibers (1) and show residual properties after impact or overload.

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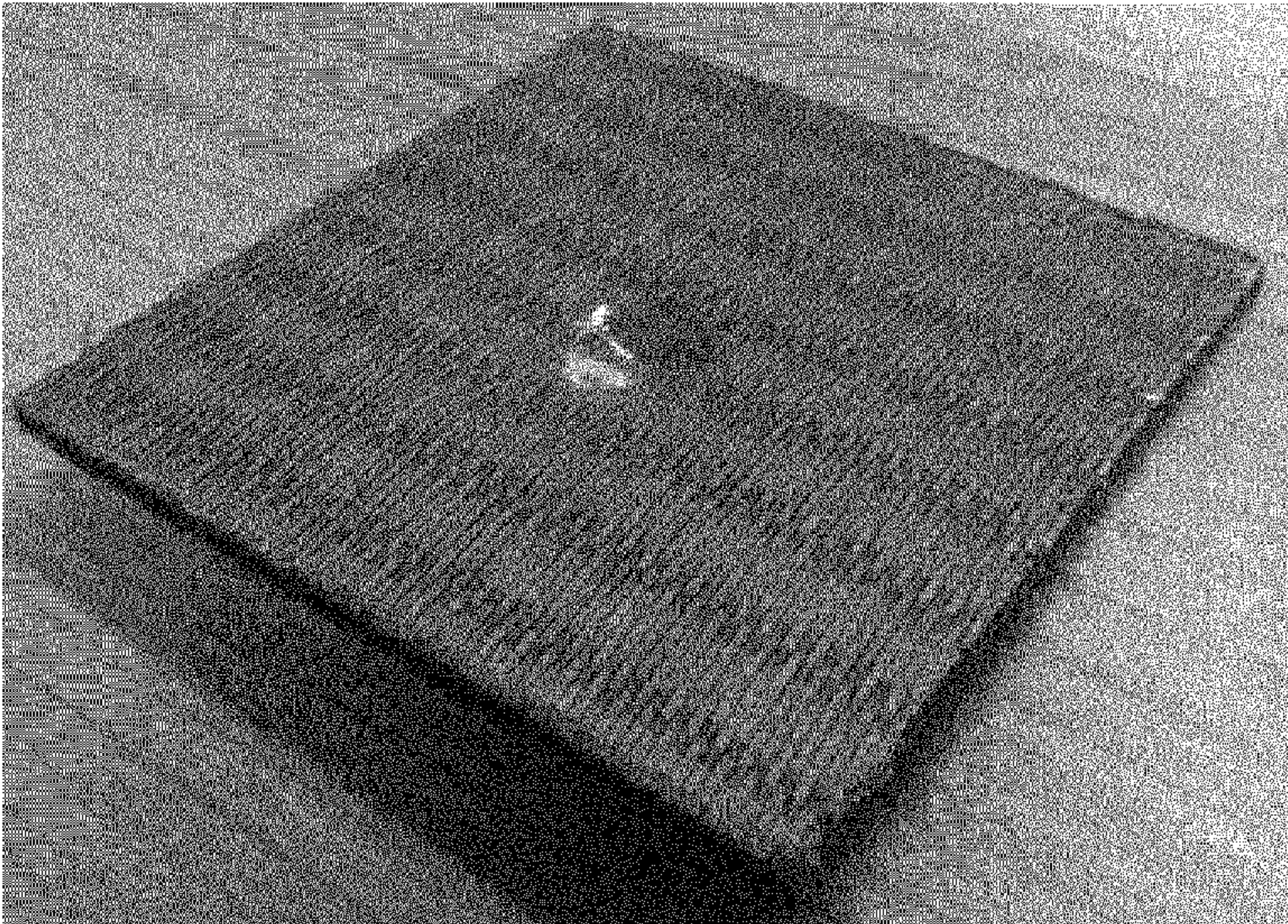


FIG. 20

(57) Abstract: A hybrid composite comprising a thermoplastic or thermoset matrix in which brittle and ductile fibers (1) are present, characterized in that the fibers are configured such that the ductile fibers (1) of the hybrid composite dissipate energy at a impact or overload by plastic deformation of the ductile fibers (1) and show residual properties after impact or overload.

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Claims

1. A hybrid composite, the hybrid composite comprising: a thermoplastic or thermoset matrix in which brittle and ductile fibers (1) are present, characterized in that the ductile fibers are present individually or contained in a yarn having a twisting angle of less than 5° or bein untwisted, the stiffness of the brittle and ductile fibers is greater than 150 GPa, the ductile fibers have a elongation at break being larger than 5%, the fibers being configured such that the ductile fibers (1) of the hybrid composite on impact or overload dissipate energy by plastic deformation of the ductile fibers (1) and the hybrid composite retains integrity after impact or overload.
2. The hybrid composite according to the previous claim, wherein the fiber volume fraction of the ductile fibers (1) is less than 50% of the total amount of fibers, preferably less than 20%, for example between 3% and 10%.
3. The hybrid composite according to any of the preceding claims, wherein the stiffness of the brittle and ductile fibers is larger than 190 Gpa and / or wherein the elongation at break of the ductile fiber is greater than 15%.
4. The hybrid composite according to any of the preceding claims, wherein the fibers preferably have a diameter of less than 100µm and preferably less than 40µm and / or wherein fibers are packed close together.
5. The hybrid composite according to any of the preceding claims, wherein the brittle and / or ductile fibers have a rough and / or irregular surface so that they bond better to the matrix.
6. The hybrid composite according to any of the preceding claims, wherein the ductile fibers comprise polygonal cross sections and fit well when the ductile fibers are placed unidirectionally and realize a local high fiber volume fraction.
7. The hybrid composite according to any of the preceding claims, wherein the ductile and / or brittle fibers are placed unidirectionally in a homogeneous layer.
8. The hybrid composite according to any of the preceding claims, wherein the ductile fibers are provided in a fabric (100).
9. The hybrid composite of claim 8, wherein a yarn with untwisted ductile fibers (1) is used as weft yarn and wherein the warp yarn consists of an untwisted polymer yarn (20) with a high shrinkage.
10. The hybrid composite according to any of the preceding claims, wherein the brittle fibers are provided in a fabric, a braid, a knit, a non-crimp fabric (NCF), or a random fiber mat.

11. The hybrid composite according to any of the preceding claims, wherein the ductile fibers are provided with their longitudinal axis perpendicular to an expected cracking direction of the composite.
12. The hybrid composite according to any of the preceding claims, wherein the brittle fibers
5 and ductile fibers are provided in an interlayer configuration resulting in a hybrid laminate, with at least one ductile fiber layer.
13. The hybrid composite according to claim 12, wherein the at least one ductile fibrous layer is positioned on at least one surface of the composite, where the largest distortions can occur and where the cracking can show the largest opening.
- 10 14. The hybrid composite according to claim 13, wherein the at least one ductile fiber layer is placed on at least one largest surface of hybrid composite;
15. The hybrid composite according to any of the preceding claims, wherein the brittle fibers are carbon fibers and / or the ductile fibers are stainless steel fibers.
16. The hybrid composite according to any of the preceding claims, wherein the composite is
15 a laminate or sandwich plate or wherein the composite is a tube or a profile.
17. The hybrid composite of claim 16, wherein the composite is a tube or profile and wherein the curvature of the tube or profile contributes to the integrity of the hybrid composite.
18. A vehicle component comprising a hybrid composite according to any one of claims 1 to
20 17.
19. A method of making a hybrid composite according to any of claims 1 to 17, the method comprising
 - placing the brittle and ductile fibers on a mold of a predetermined shape;
 - infusing the fibers with a thermoplastic or thermoset resin to form a hybrid composite.
- 25 20. A method of making a hybrid composite according to any one of claims 1 to 17, the method comprising:
 - providing an object containing brittle fibers,
 - providing at least one ductile fiber layer on at least one surface of the article.