OPTIMISATION OF CARBON FIBRE DISPERSION IN FLUID MEDIUM

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Research background

The randomly oriented recovered carbon fibres derived from current recycling techniques are unsuitable for use in the production of high-strength structural components. Remanufacturing of FRP material with higher tensile strength and inter-laminar shear strength can be facilitated by developing highly effective realignment methods for recycled fibres [1].

Analytical hierarchy process and fuzzy comprehensive evaluation methods were used to systematically rate the effectiveness of the existing fibre alignment methods in realigning recycled fibres, with results suggesting that the hydrodynamic approach is an effective process for fibre alignment and leads to higher efficiency [2].

For successful hydrodynamic alignment, adequate and stable fibre dispersion should be accomplished by optimising the fluid's fibre dispersion. Well-performed fibre dispersion is beneficial for minimising flocculation, keeping a consistent concentration of fibres in the solution, boosting dispersion productivity by avoiding obstruction, minimising fibre damage caused by interweaving, and achieving a high degree of fibre realignment in later phases.

Image processing for detecting fibres

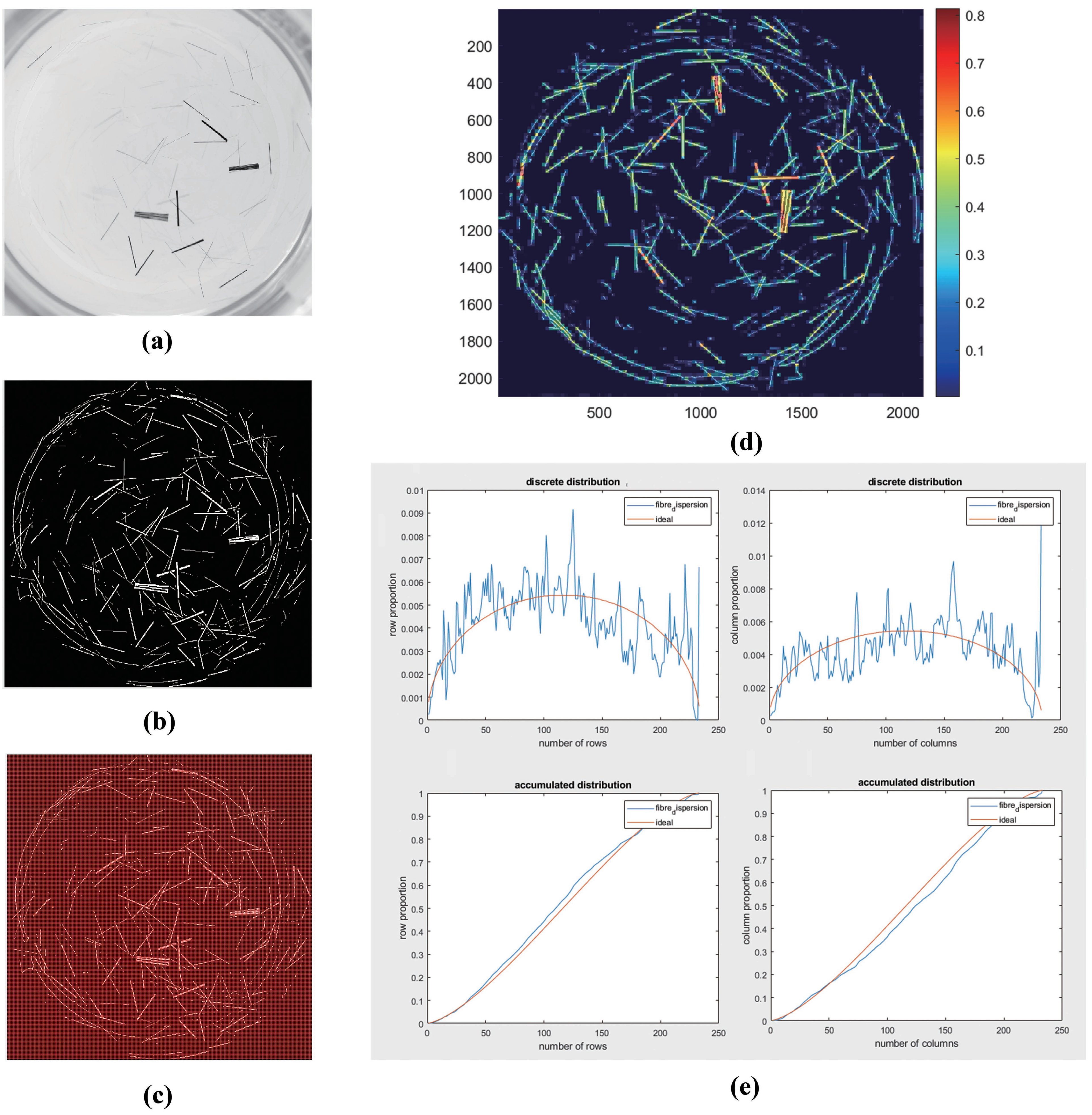


Image processing: (a) Photo of fibre dispersion, (b) All fibres detected via inhouse software, (c) Mesh the region of interest into small squares ,(d) distribution of fibre and (e) detection analysis (includes row/column discrete distribution analysis and row/column accumulated distribution)

Measurement of the dispersion degree

Fibre disperison degree

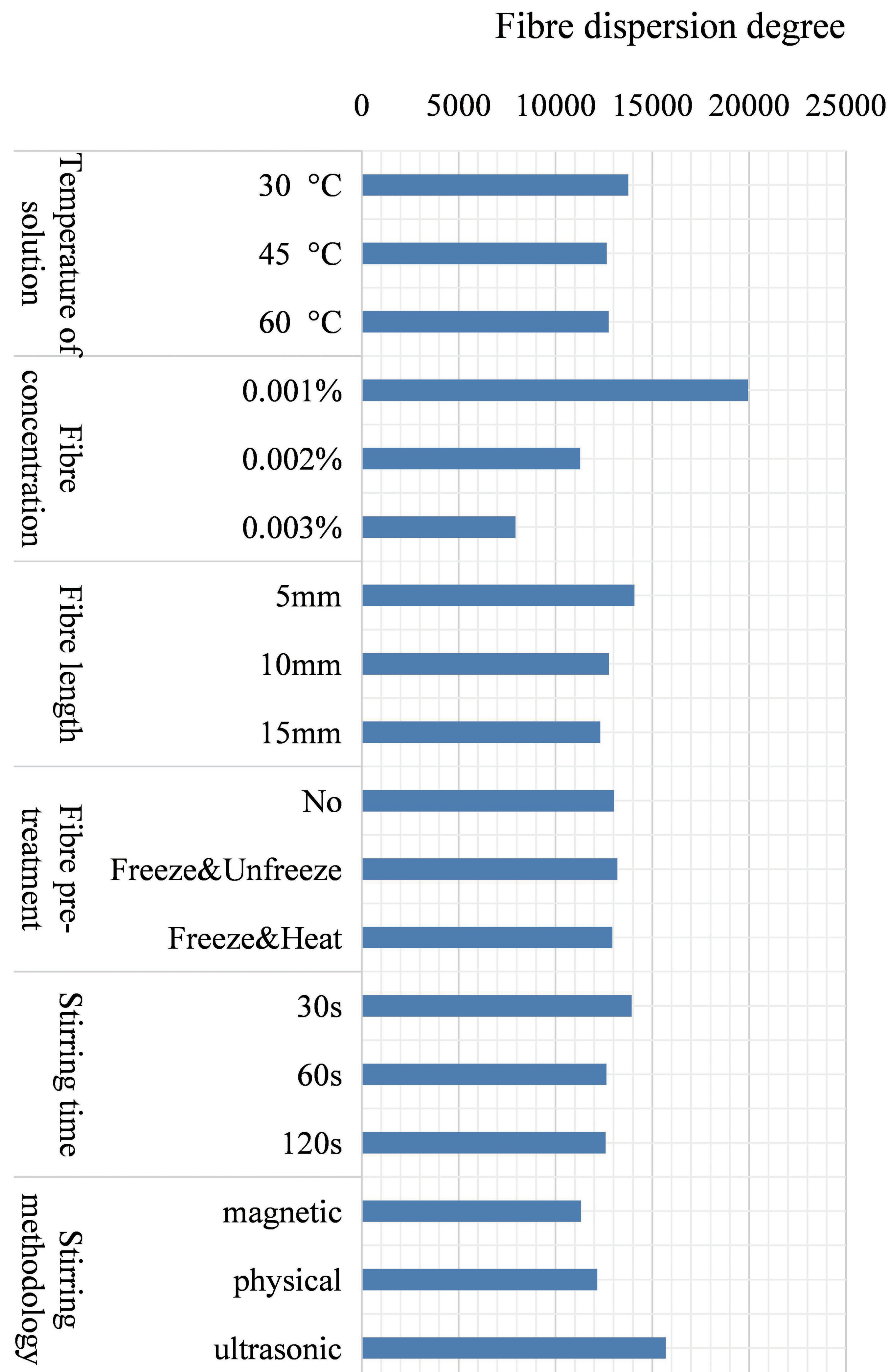
$$= \mathrm{all}_{SD} \times \sqrt{Coef_{row}^2 + Coef_{col}^2} \div Weight\ fraction_{fibre}$$

$$= \mathrm{all}_{SD}^{\left\{(1-0.05)^{\left\{\frac{\left|\left[\frac{(1-fibre\ bundle\ percentage)*fibre_{SD}}{all_{SD}}-75\%\right]\right|}{15}\right\}}\right\}} \times \sqrt{Coef_{row}^2 + Coef_{col}^2} \div Weight\ fraction_{fibre}$$

where all_{SD} is the standard deviation of the proportion of fibre pixels in the square of the i-th row and j-th column, which quantifies the importance of deviations from the ideal distribution; Coef_{row} and Coef_{col} represent the correlation coefficient for each square rows and columns when comparing the actual distribution to the ideal distribution; weight fraction fibre is the proportion of identified fibres' pixcel inside the region being analysed; fibre bundle percentage is a proportion of fibres that are discovered as bundles. A higher percentage indicates that a greater number of threads have not been properly disseminated, since they appear as bundles rather than as independent strands; fibre_{SD} is the standard of fibre pixels per square with a visible fibre structure.

The relevance of each variable on the degree of fibre dispersion

The illustration of the optimal dispersion configuration



Acknowledgement

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Reference

[1]O. Géraldine, L. B. Jean, G. Arnaud, M. Olivier M. and A. L. Gary Recovery and reuse of discontinuous carbon fibres by solvolysis: Realignment and properties of remanufactured materials, "Composites Science and Technology", vol. 139, pp. 99-108, 2017.

[2] Y. Wei and S. A. Hadigheh Systematical evaluation of fibre alignment methods in FRP remanufacturing. "The Seventh Asia-Pacific Conference on FRP in Structures (APFIS 2019)", Surfers Paradise, Gold coast, Australia, 2019.