Scale Effects in Fibre Composites and Surface Coatings: Microstructure, Transport Phenomena and Mechanics

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Microstructural control is a familiar element of Materials Science, commonly extending over a wide range of length scales. However, there are often complex interplays between processing route, microstructural features (including their scale), material properties and the performance requirements of the product (component). These interplays will be illustrated via four case histories, all relating to composite "systems" of various types - ie assemblages of two (markedly) different constituents, one of which might be air. The emphasis will be on the significance of the ***architecture*** of these assemblages, including their scale. The cases listed below will be considered, with the value of λ indicated in each instance representing the approximate scale of the architecture that is likely to result in optimal performance. The emphasis is on applications for which transport phenomena (such as heat transfer and fluid flow) and mechanical durability are of central importance. Mention will also be made in each case of the degree to which commercial development has been enhanced by the research concerned.

- Molten aluminium-derived alumina fibres, assembled into networks for ultrafiltration (λ ~ 10 nm): {*USAF range of filters*}
- Plasma sprayed zirconia coatings for thermal insulation (λ ~ 1 μm): {*XCL range of Thermal Barrier Coatings*}
- Sintered steel fibre networks for heat exchangers (λ ~ 100 μm)
- Steel fibre reinforcement for toughening of ceramics (λ ~ 1 mm): {*Fiberstone products*}

A key message is that refinement of the scale of the microstructure, while beneficial in some situations, can be ineffective or deleterious in others.