



4th International Symposium on
Energy **C**hallenges & **M**echanics
- working on small scales

11-13 August 2015
Aberdeen, Scotland, UK

Simultaneously ultrastrong and tough continuous nanofibers for next generation lightweight structural composites

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Accepted for publication on 19th July 2015

Modern advanced fibers are strong but brittle, leading to unnecessary high factors of safety in advanced composite structures. This in turn leads to increased weight and energy consumption in transportation, aerospace, and other applications. Novel nanomaterials such as CNT and graphene have raised hopes for the development of stronger structural materials. However, problems with their dispersion, alignment, achieving high volume fraction, and interfacial stress transfer have proven difficult to resolve. Recently, a different class of nanomaterials, i.e. continuous nanofibers, has shown unusual mechanical properties. This presentation will review the status and recent breakthroughs on ultra-high-performance continuous nanofibers and their composites. Examples of pioneering high-performance polymer, carbon, and ceramic nanofibers will be presented. Unique, extraordinary simultaneous increases in strength, modulus, and toughness in nanofibers with their diameter decrease will be presented and explained. Recent progress on nanofiber-reinforced supernanocomposites will be discussed. Finally, possibilities for the ultrastrong and tough continuous nanofibers to enhance or even replace carbon as a new reinforcement for the economic next generation lightweight structural composites will be evaluated.

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Keywords: high strength, toughness, continuous nanofibers, lightweight composites



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