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Editorial

Nanofibers: Friend or Foe?

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Since the early 1990s nanofibers, particularly those of a carbonaceous content [1] have received heightened interest due to their advantageous physico-chemical characteristics (e.g., high strength, stiffness, semi-conductor, increased thermal conductivity and one of the highest Young's modulus [2]). Such attributes have caused increased debate regarding their potential use as a fundamental component in a wide range of new, advantageous materials for consumer, industrial and medical applications [2]. Yet, concomitantly, due to their dimensions, as well as chemical and elemental structure, concerns as to the human health risk associated with exposure to nanofibers have been vehemently raised [3–5]. Thus, there remains an impending need to undertake research initiatives that focus specifically upon determining the real advantages posed by nanofibers, as well as underpinning their conceivable risk to human health. Both are inextricably linked, and therefore by devising a thorough understanding of the synthesis and production of nanofibers to their potential application and disposal is essential in gaining an insight as to the risk they may pose to human health.

In this Special Issue of *Fibers*, seven publications (two original articles and four full-length reviews as well as one opinion) are dedicated towards further understanding the nanofibre paradox, notably considering (i) the advantageous structure and mechanical material properties; and (ii) what areas must be considered for future research.

Initially, Yao and colleagues [6], in a paper entitled '*High strength and high modulus electrospun nanofibers*', describe, through a detailed review, the ability to create nanoscale continuous fibers *via* the simple method of electro-spinning. This paper highlights just one of the many possibilities to synthesize nano-sized fibers that elicit high strength and high modulus characteristics, providing essential guidance for future activities in this context. Such future activities are subsequently shown by Schaer et al. [7], who describe the effectiveness of co-encapsulating different forms of nanomaterials (i.e., nanophosphors and superparamagnetic iron oxide nanoparticles) in either polystyrene micro- or nano-fibers using electro-spinning techniques. Through a sophisticated approach, it has been shown that such electro-spun nanomaterials can be used as promising multi-functional magnetic photoluminescent photocatalytic nano-constructs.

Continuing further, the potential application of nanofibers is then touched upon by Hatanaka et al. [8], who report the ability for cellulose nanofibers, a new and exciting nanofiber type, to form hierarchical self-assembled films. In this original article, which highlights an alternative way of approaching soft nanoscience, it was reported that via an unconventional, bottom-up process, they were able to show that the hierarchically self-assembled nanofibers promoted increased, advantageous level of mechanical properties when under tensile mode.

The context of the Special Issue then changes direction, going from the production and application of nanofibers to the other end of their life-cycle, focusing on the potential release of nanofibers from polymer matrices. In a full-length review, Schlagenhauf and colleagues [9] discuss the ability for carbon nanotubes to be released from polymer nanocomposites under a variety of stress-induced scenarios, including mechanical impact, weathering and fire. This comprehensive article highlights an area of increasing interest within the field of nanotoxicology, especially since the release of nanomaterials in such a scenario would mimic that which humans would be directly exposed to, either accidentally or within an occupational setting.

In context of considering the potential adverse impact of nanofibers upon human health, understanding their physico-chemical characterisation is a must [10]. Recently, in addition to this, the determination as to how nanomaterials interact with their non-cellular, biological environment (i.e., interaction with proteins) has highlighted another avenue of nanomaterial characterisation that will help further deduce their interaction with extra- and intra-cellular entities, such as proteins. Most notably however, understanding how nanomaterials interact with protein complexes has been performed upon spherical-shaped nanomaterials [11], with limited understanding concerning the nanofiber-protein interaction. Therefore, to provide a thorough overview of how proteins interact with fiber-shaped nanomaterials, Kucki et al. [12] highlight recent studies that investigate these complexes and discuss what such interactions may mean towards the hazard potential of nanofibers as well as give indications for future research in this area. Continuing on the theme of the biological impact of nanofibers, Boyles and colleagues [13] discuss the ability for nanofibers to cause inflammation. Focusing upon inhalation exposure, although also touching upon other exposure routes, the effects noted from both in vivo and in vitro research studies following carbon nanotube exposure are discussed. Most notably, this article refers to the potential impact of carbon nanotubes upon the human immune system, and what the consequences of such an interaction might be.

Finally, the Special Issue culminates with an opinion that looks beyond carbon-based nanofibers, specifically nanofibers composed of cellulose. Camarero-Espinosa, Endes and Mueller et al. [14] highlight cellulose nanocrystals, a new form of nanofiber receiving increased attention due to their advantageous physical and mechanical characteristics. This opinion-based article is focused towards the essential need for attaining knowledge of the biological impact of cellulose nanocrystals, with a special focus upon human health effects. Based upon the view of progressing nanotoxicological assessment of new nanomaterials, the authors providing a strong, yet clear indication as to how future research activities regarding this exciting nanomaterial must be conducted in order to fully comprehend its biological impact (to human health).

In summary, this Special Issue entitled 'Nanofibers: Friend or Foe?' provides significant insight into the nanofiber paradox, with (i) the potential applications posed by nanofibers; and (ii) a discussion of the many issues that remain unresolved in regards to their potential risk towards human health. Discussing major and important components that must be considered within the field, this Special Issue allows for a clear understanding of the problems being encountered combined with a number of definitive solutions as to how to move forward in order to realise the advantages encouraged by these nano-sized materials.

Conflicts of Interest: The authors declare no conflict of interest.

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