Hybrid Materials for Interactive Wound Dressing

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Highly appealing hybrid aerogel materials with desired properties to be used as interactive wound dressing materials have been synthesized by combining organofunctionalized mesoporous silica nanoparticles trapped into hyperbranched polymer networks comprising of biocompatible polymers, Figure 1.[1]

Wound dressings are biomaterials, which can be classified as passive, active, or interactive. Passive wound dressing serves only as a protective layer, while active wound dressings act on the healing process by the control of moist in the wound environment. Interactive wound dressings are more advanced materials than the previous ones since it acts as a protective layer, control the moist of the wound and it also interacts with the biologic system speeding up the healing process. For instance, an active wound dressing can release an anti-inflammatory drug to reduce the inflammatory response and relieve pain, the continuous control of the fungi and bacteria proliferation, reduce the level of exudate, and improve cellular proliferation.

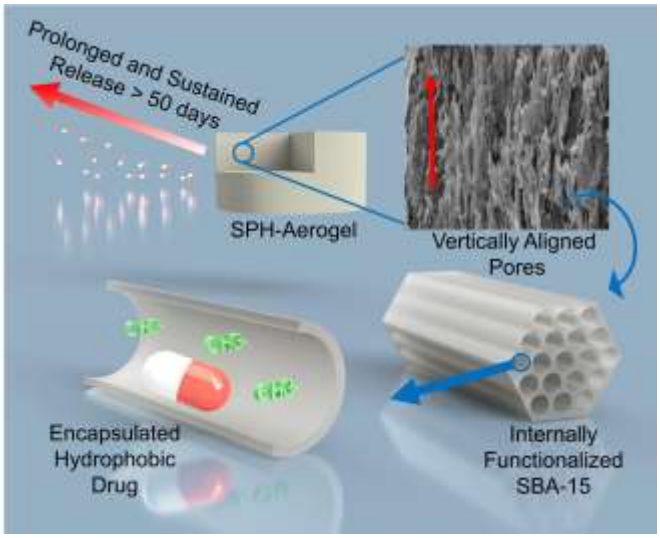

Figure 1. *Schematic representation of the composition of the hybrid material.*

The synthetic method explores the synthesis of aerogel from polymeric solution with inorganic nanoparticles dispersed by freeze-drying process followed by thermally formed cross-links, Figure 2. Water-stable aerogels with controlled structures and well-aligned pores are formed. The general properties of the hybrid aerogel can be tuned by changing the relative amount of the mesoporous silica nanoparticles, the nature of the polymer network, the solid-to-liquid (S/L) ratio in the solution prior freeze-drying process, and the density of functional groups in the internal surfaces of the mesoporous silica nanoparticles. Aerogels with different bulk densities, high adsorption capacity, and prolonged release properties for a hydrophobic drug have been synthesized. The hybrid aerogels have been shown to serve as ideal host materials for the hydrophobic drug, but the hybrid system can be designed for drugs with different chemical features by changing the internal modifiers groups of the mesoporous silica.

In some cases, the hybrid materials can exhibit prolonged and sustained release profiles for as long as two months period. Both components of the hybrid aerogels have been found to be responsible for these properties: while their organofunctionalized mesoporous silica nanoparticles have allowed the aerogels to have a high loading capacity, their polymer matrices have provided physical stability and slow and prolonged release profiles for the adsorbed molecules. So, the new design and synthetic approach successfully demonstrated that by incorporating mesoporous silica nanoparticles within hyperbranched polymer aerogels and creating strong enough interactions for hydrophobic drug molecules with chemically modified internal pores of trapped nanoparticles can possibly be extended to make other highly effective drug delivery systems that are difficult to make otherwise.

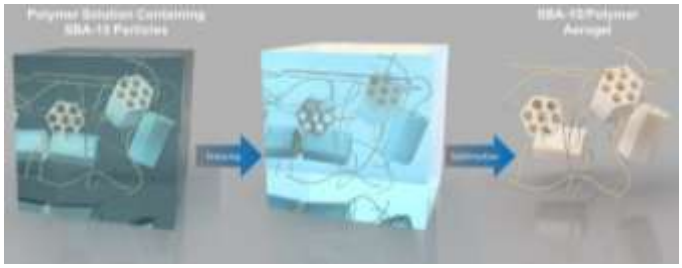

Figure 2. *Schematic representation of the freeze-drying process to form hybrid aerogels.*

The *in vitro* cytotoxicity and cell proliferation results have shown that the aerogels had no toxicity for Vero cells and displayed a good cell proliferation for L929 cells. The silica nanoparticles intentionally functionalized (externally) with quaternized groups and dispersed into the aerogels showed good antibacterial activity, that is an important feature contained in the materials. The results overall have indicated that the aerogels could be used as drug carriers in biological environments, especially as sustained drug delivery systems, in other words, to systems that require a long period of drug release as can be the case of wound care dressings, or among other things.

References

1. Follmann, H. D. M.; Oliveira, O. N.; Lazarin-Bidoia, D.; Nakamura, C. V.; Huang, X. X.; Asefa, T.; Silva, R., Multifunctional hybrid aerogels: hyperbranched polymer-trapped mesoporous silica nanoparticles for sustained and prolonged drug release. *Nanoscale* **2018,** *10* (4), 1704-1715.