Journal of Dermatology and Dermatitis

George W. Dombi[1*]. J Dermatology and Dermatitis
http://doi.org/08.2018/1.10005

Short Report | Open Access

Collagen Nanotube, a Possible Wound Covering

George W. Dombi[1*], Kaushalkumar Purohit[1], Sze C. Yang[1], Lenore M. Martin[2]

[1]Department of Chemistry, University of Rhode Island Kingston, USA.
[2]Department of Cell and Molecular Biology, University of Rhode Island Kingston, USA.

*Corresponding Author: George W. Dombi, PhD Department of Chemistry, University of Rhode Island Kingston,USA,
E-mail: Gdombi@Chm.uri.edu

Received date: February 06, 2018; Accepted date: March 06, 2018; Published date: March 09, 2018.

Citation this article: George W. Dombi, Kaushalkumar Purohit , Sze C. Yang, Lenore M. Martin, Collagen Nanotube, a possible wound covering. J.Dermatology and Dermatitis, **DOI:**10.31579/2578-8949/026

Copyright: © 2018 George W. Dombi et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

In 2015, we had a manuscript published entitled: Collagen Gel Formation in the Presence of aCarbon NanoBrush [1]. In that manuscript, evidence was presented that type I, bovine skin collagen was able to gel in the presence of various concentrations of a carbon nanotube material, covered with a polystyrene/polyaniline copolymer, called a carbon Nanobrush, CNB. The rate of collagen gelation was enhanced by the presence of the CNB in a dose dependent manner. The extent of collagen gelation was due to the concentration of collagen and not the amount of CNB. Collagen D-periodicity, and average fibril diameter were unchanged by the CNB material as seen in transmission electron micrographs. Gel tensile strength was reduced by the presence of the CNB in a dose related manner.

For nearly 20 years, researchers have been trying to perfect an *in-vitro* collagen matrix material to aid in wound healing and collagenous tissue repair, [2]. These collagen constructs form easily but are relatively weak, [3]. A number of cross-linking agents have been added to try to stiffen the collagen gel, but many are detrimental to the biocompatibility of the resulting matrix, [4, 5]. Since the discovery of carbon nanotubes in 1991, by Iijima [6] this form of linear carbon nanostructures are seen as having potential biomedical applications. Carbon nanotubes are either single walled (SWNT) or multiple walled (MWNT) cylinders of carbon atoms, defined by diameter, length and twist. Carbon nanotubes have a very high aspect ratio with length > 100 nm [7]. Carbon nanotubes became an important co-polymer with collagen for biomedical applications and tissue engineering beginning in 2004, showing promise in neural and orthopedic tissue engineering applications because of their electric conductivity and high tensile strength, [8,9].

Collagen gels, in the presence of the CNT, did gel with the normal had normal size collagen D-period bands (1), however, the gels were progressively blacker as a result of the increasing amount of carbon; see Figure 1. As a skin cover, this material would have been 'pre-tatooed' as the carbon nanotubes darken the collagen gel like injecting tatooing ink under the epidermis darkens the skin.

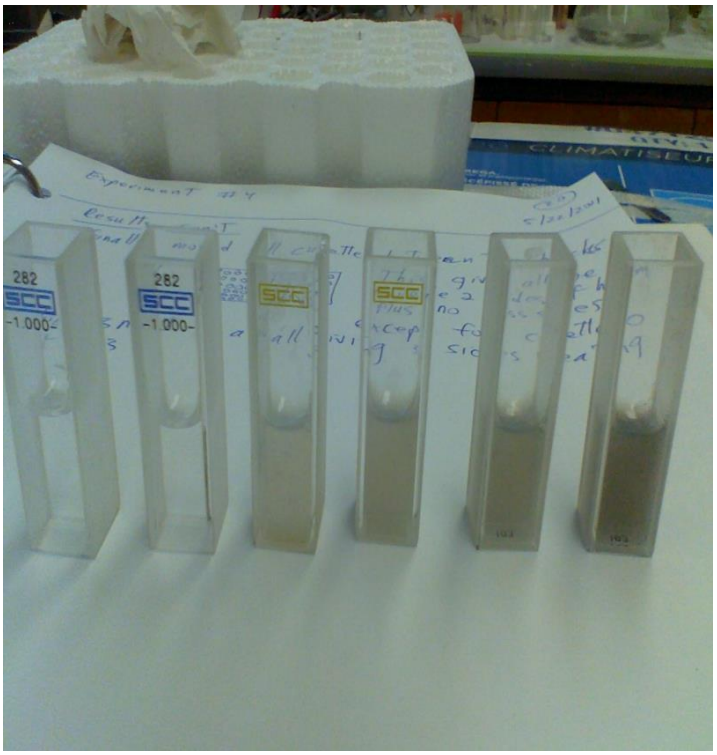

Figure 1: Collagen / carbon nanobrush, CNB, gels. (Left to right) (1) buffer only, (2) collagen solution only, (3) collagen + 10 ul CNB, (4) collagen + 25 ul CNB, (5) collagen + 50 ul CNB and (6) collagen + 100 ul CNB.

When the contents of these cuvettes were dried, they became like darkened cellophane. It can be imagined that at very high CNB concentration the resulting film would look like commercial carbon fiber materials; see Figure 2. Note that the image in Figure 2 is not made by us but it is what I imagine a collagen/CNB fabric would look like when woven in thing strips.

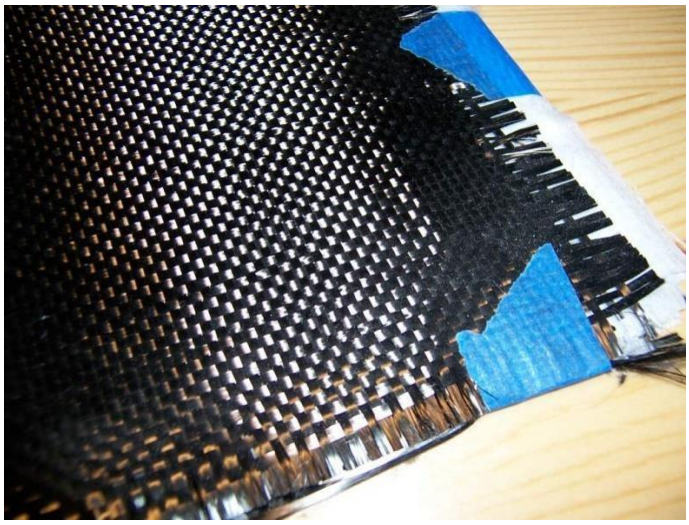

Figure 2: Woven commercial carbon fiber cloth. https://en.wikipedia.org/wiki/Carbon_fibers

The goal of our collagen/CNB work is to produce a collagen hydrogel material that is fibroblast compatible and has a tensile strength that can be controlled by the amount of CNB added. When this material is dried, it can be used as a covering for different types of tissue repair that require different levels of collagen gel tensile strength. It is hoped that the collagen/CNB mixture will have a future role in the repair and reconstruction of wounds or repair of degenerated connective tissue.

Any concerns that the collagen/CNB material would have too high of a visual contrast when placed on skin appears to not be a problem especially in the future as seen in Science Fiction.

In Figure 3, we see Kylo Ren is sporting what must be a collagen-CNB wound covering to help heal a light saber injury to the face. Notice the carbon cloth weave and texture and the carbon-black color of the dressing.

Figure 3: Kylo Ren, from Star Wars, The Last Jedi sporting what must be a collagen/CNB bandage. https://www.popsugar.com/entertainment/Kylo-Ren-Scar-Star-Wars-Last-Jedi-44127899

References:

1. Dombi GW, Purohit K, Martin LM, Yang SC. (2015). Collagen gel formation in the presence of a carbon nanobrush. Journal of Materials Science; 26: 5356.
2. A. Sterodimas, J. De Faria, W. E. Correa ,I. Pitanguy, (2009)Tissue Engineering in Plastic Surgery, an Up-to-Date Review of the Current Literature. Ann Plast Surg; 62: 97-103.
3. E.A. Abou Neel, L. Bozec, J.C. Knowles, O. Syed, V. Mudera, R, et al.(2013) Collagen – Emerging Collagen Based Therapies Hit the Patient, Adv Drug Deliv; 65: 429-456.
4. Charulatha, A. Rajaram,(2003) Influence of Different Crosslinking Treatments on the Physical Properties of Collagen Membranes. Biomaterials; 24:759-767.
5. H. Rich, M. Odlyha, U. Cheema, V. Mudera and L. Bozec, (2013) Effect of Photochemical Riboflavin-mediated Crosslinks on the Physical Properties of Collagen Constructs and Fibrils, J Mater Sci: Mater Med; 25:11-21.
6. S. Iijima,(1991) Helical Microtubules of Graphitic Carbon, Nature, 354 : 56-58.
7. B.S.Harrison,A.Atala,(2007) Carbon Nanotube Applications for Tissue Engineering, Biomaterials; 28: 344-353.
8. T.S. Girton, R.R. Oegema ,R.T. Tranquillo,(1997) Exploiting Glycation to Stiffen and Strengthen Tissue Equivalents for Tissue Engineering. J. Biomed Mater Res, 46: 87-92.
9. H. He and T. Matsuda,(2002) Arterial Replacement with Compliant Hierarchic Hybrid Bascular Graft: Biomechanical Adaptation and Failure. Tissue Eng, 8:213-224.