DISORDER/ORDER AND ASYMMETRY/SYMMETRY TRANSITIONS OBSERVED IN LABORATORY PRODUCED COLLAGEN MEMBRANES

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Abstract: *A novel biomaterial made of collagen, that would presumably be useful in medicine was recently presented [1]. This material is a membrane made of the protein, ordered at a molecular level. Collagen is a highly occurring protein in several body tissues and the molecule has a cylindrical geometry. It first arranges in fibrils, then into fibers, to finally conform very ordered aggregates like the skin. Each aggregates posses its own pattern, according to the relevant function. Collagen membranes, with no molecular order, have already been used for several purposes, even in industry. Two alternative methods to produce soluble collagen and then ordered membranes were patented in 1999 and 2006, respectively [2]. UV and IR spectra reveal a high purity degree of the material. Optical, Laser Scanning, and Electronic microscopic observations and laser diffraction experiments show a high level of order in the obtained membranes. A few details in the observed experimental images are the base to intent an analysis of the disorder/order or asymmetry/symmetry transitions in these membranes.*

1 INTRODUCTION

In nature tropocollagen molecules associate into fibrils, and then into fibers that can reach as big sizes as tendons or tissues like skin, as it is schematically in Figure 1.

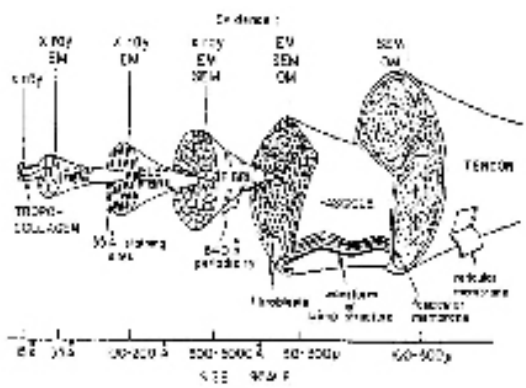

Figure 1. Consecutive association of tropocollagen molecules versus size scale.

The collagen membranes, currently used for several purposes, even in industry, present some degree of order at a certain scale level, as it is represented in Figure 2.

Figure 2. Cross-links between collagen strands (Science, 8 February 2002, 1011).

However, according with increased size scale these membranes of tropocollagen molecules arrange in a fairly random way. In the case of skin therapies it is crucial that membranes present the same molecular order as the skin. For this reason two alternative methods [2] to obtain acidic solutions of native collagen of 98% purity soluble collagen and then to produce the supramolecular aggregation ordered membranes were recently communicated [1]. In fact, aggregation itself does not warrant build up ordered membranes by using uncontrolled procedures, as it is shown in the SEM image at Figure 3. However, following the recepy of the patented methods well molecular ordered membranes are obtained, as that shown in Figure 4 at four different SEM magnifications.

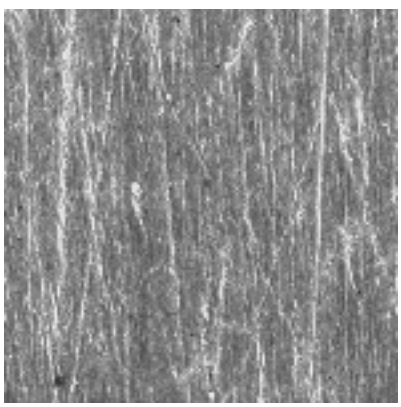

Figure 3. Disordered collagen membrane. SEM image scale 63,37 x 63,75 µm2 at a x1000 magnification.

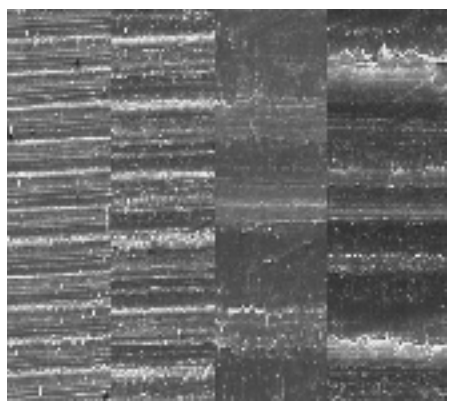

Figure 4. Ordered collagen membrane. SEM image scales 1.580, 640, 160, 63,75 µm at x40, x100, x400, and x1000 magnifications.

2 ORDER/DISORDER AND SYMMETRY/ASYMMETRY TRANSITIONS

SEM images of a cross sections of molecular ordered membranes of collagen resembles that of a puff pastry, as it is shown in Figures 5 a), b), c), and d). The SEM images displayed in Figure 5 were obtained at x600, x1200, x2400, and x5000 magnifications, respectively.

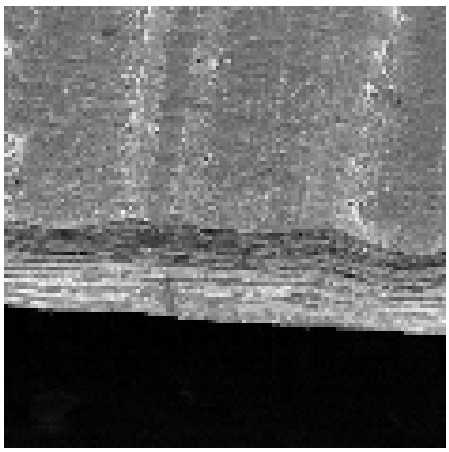

Figure 5 a) SEM image of a cross section of an ordered collagen membranes at x600.

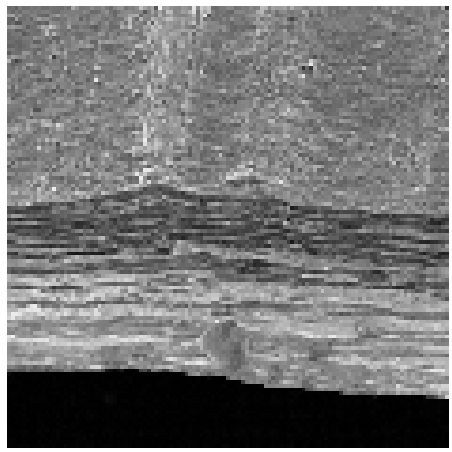

Figure 5 b) Idem to Figure 5 a) at x1200.

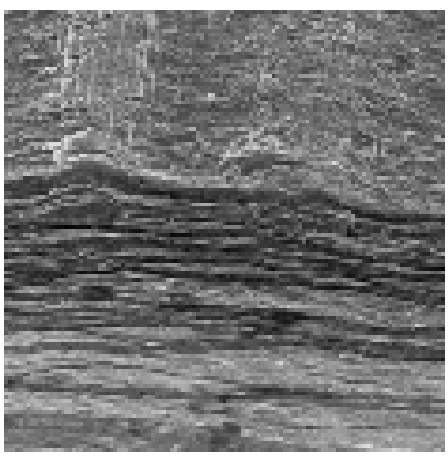

Figure 5 c) Idem to Figure 5 a) at x2400.

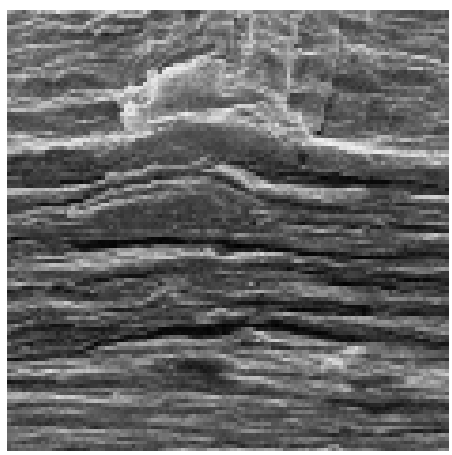

Figure 5 d) Idem to Figure 5 a) at x5000

A few details in the observed experimental images at Figure 5 resemble that SEM image of a cellular polymer shown at Figure 6. The puff pastry like structure of the cellular polymer is attributed to static electric charges. Then, probably a similar effect occurs in the ordered collagen memebranes to espontaneously develop the disorder/order or asymmetry/symmetry transitions while collagen membranes are bild up following the recepy of the patented methods. This conjecture must be confirmed by an appropriate investigation in the future.

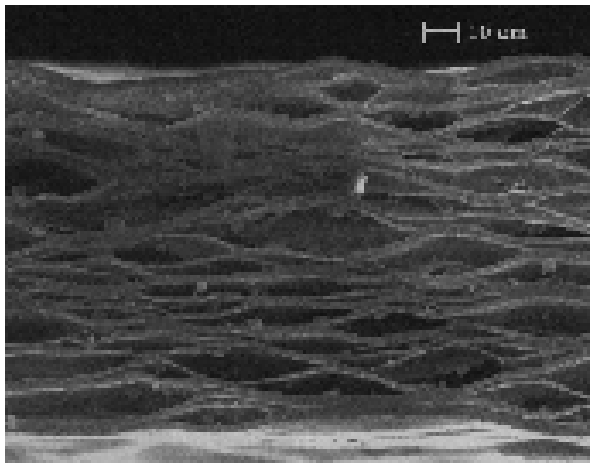

Figure 6. SEM image of a cross section of a cellular polymer. (Physics Today, February 2004, 37-43).

References

Novel biomaterial useful for several medical purposes. Production and characterization. G. Ruderman, I. G. Mogilner, E. J. Tolosa, N. E. Massa, M. Garavaglia and J. R. Grigera. VI International Conference on Biological Physics (ICBP 2007) and V Southern Cone Biophysics Congress, Montevideo, Uruguay, 27 – 31 August, 2007.

Patents Nº253249 of 1999 and AR048387 of 2006.