

In Preparation:

Oriented Type I Collagen: A Review on Artificial Alignment Strategies

Spencer Cook¹, Karina Ambrock¹, Bernd Grohe² and Silvia Mittler^{1*}

¹Department of Physics and Astronomy, The University of Western Ontario, London, Ontario,
N6A 3K7, Canada

² Department of Chemical and Biochemical Engineering, The University of Western Ontario,
London, Ontario, N6A 5B9, Canada

*smittler@uwo.ca

Abstract:

Collagen is the most abundant protein in the human body and serves many functions, from mechanical stability and elasticity in tendons and bone to optical properties, such as transparency and a fine tuned refractive index in the cornea of the eye. Collagen has interested human kind since centuries; Leonardo Da Vinci has studied and drawn the tendons in the human body as precisely as possible in the 15th and 16th century. A quick look at the literature reveals easily > 200,000 hits.

This review gives a short overview on the hierarchical organization of type I collagen and oriented type I collagen structures found in nature, e.g. in the human body. It then focuses on the diverse methods implemented to mimic and fabricate artificial type I oriented collagen in 1D, 2D and 3D architectures. The applications of artificially fabricated type I oriented collagen structures are briefly discussed. The outline gives an overview on the content.

Outline:

1. Introduction

- 1.1. Collagen Basics
- 1.2. Collagen Hierarchy
- 1.3. Mechanical Properties

2. Aligned Collagen in Nature

The different alignments and corresponding organs

- 2.1. Parallel: tendon, ligament, bone
- 2.2. Woven and interwoven: healed bone, juvenile bone, skin, sclera

- 2.3. Plywood-Like: cornea
- 2.4. Radial and Circumferential: dentin, meniscus in the knee

3. Artificially Aligned Collagen Techniques

3.1. 1 Dimensional Threads and Tubes

- 3.1.1. Electrochemical (ELAC)
- 3.1.2. Extrusion (Pins method)
- 3.1.3. Electrospinning (Rotating Drum)

3.1.4. 2 Dimensional Arrays

- 3.2.1. Electrospinning
- 3.2.2. Extrusion (Counter-Rotating Cone/Syringe method)
- 3.2.3. Magnetics
- 3.2.4. Flow and/or Evaporation
- 3.2.5. Mechanical Stretching
- 3.2.6. Langmuir-Blodgett-Technique
- 3.2.7. Electrostatic Interaction on Mica
- 3.2.8. AFM
- 3.2.9. Spin-Coating – Flow Induced Shear Forces
- 3.2.10. Shear Forces on Collagen in Liquid Crystalline Form
- 3.2.11. Inkjet Printing

3.3. 3-Dimensional Gels

- 3.3.1. Magnetic
- 3.3.2. Extrusion (Liquid Crystallinity)

- 4. Summary/Conclusion/Discussion
- 5. Acknowledgements
- 6. References