Design and characterization of DNA-based hydrogels for mechanobiology

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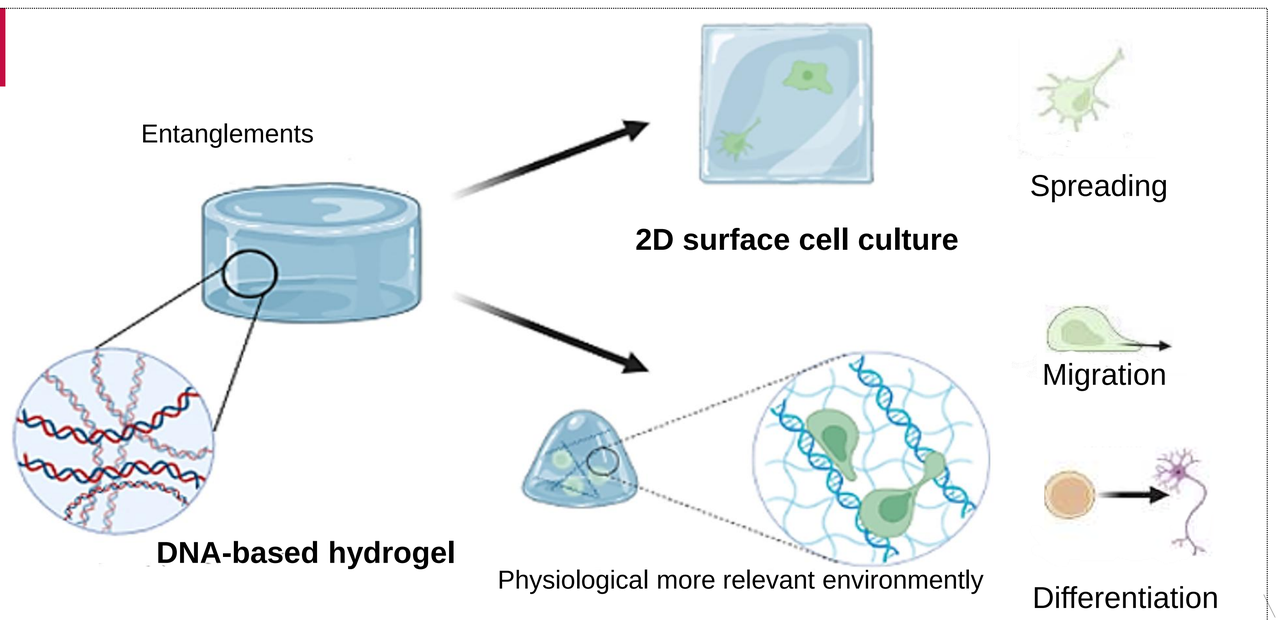
Introduction

The study of cell-matrix interactions is fundamental for understanding cell biology and the progression of diseases, and to contribute to tissue engineering and regenerative medicine. Hydrogels are biomaterials that emerged as interesting candidates to closely replicate the natural tissue environment [1]. Among them, DNA-based hydrogels have attracted considerable attention owing to the intrinsic properties of DNA such as :

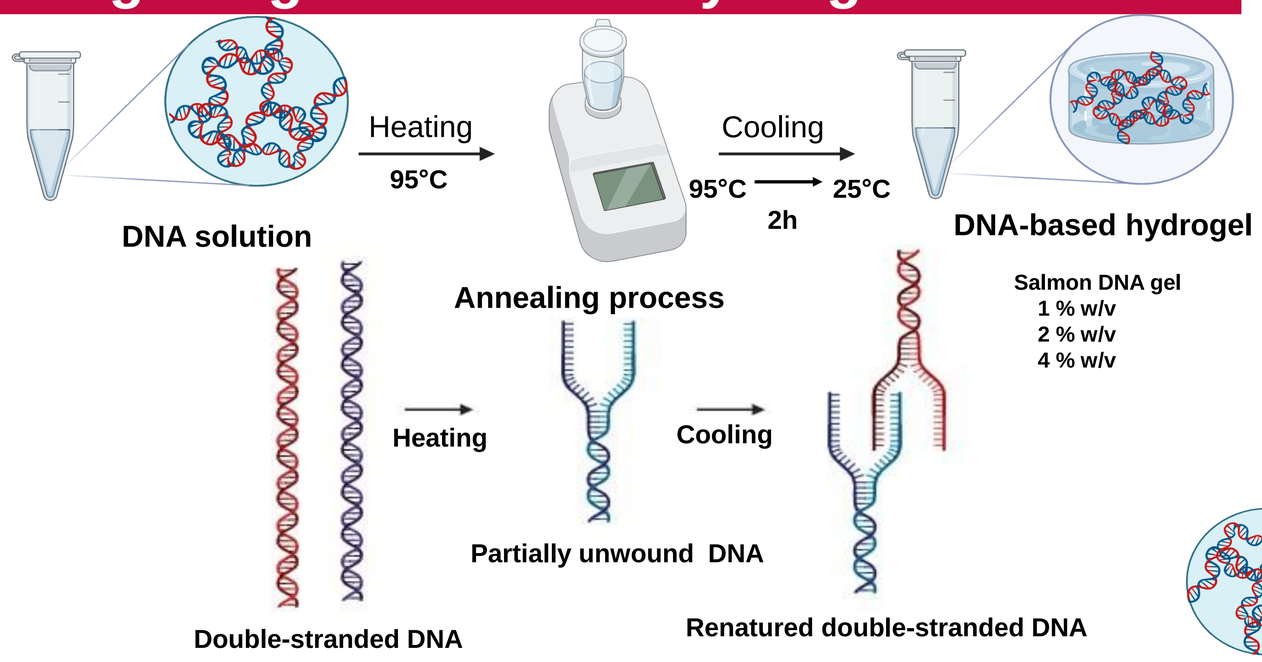
- Biocompatibility
- Programmability
- Adaptable mechanical properties [2]

Here, we have used genomic DNA to provide innovative modulable scaffolds for 2D and 3D cell culture. We have investigated the chiroptical properties of genomic DNA in aqueous solutions and gel state and measured the Young modulus by microindentation.

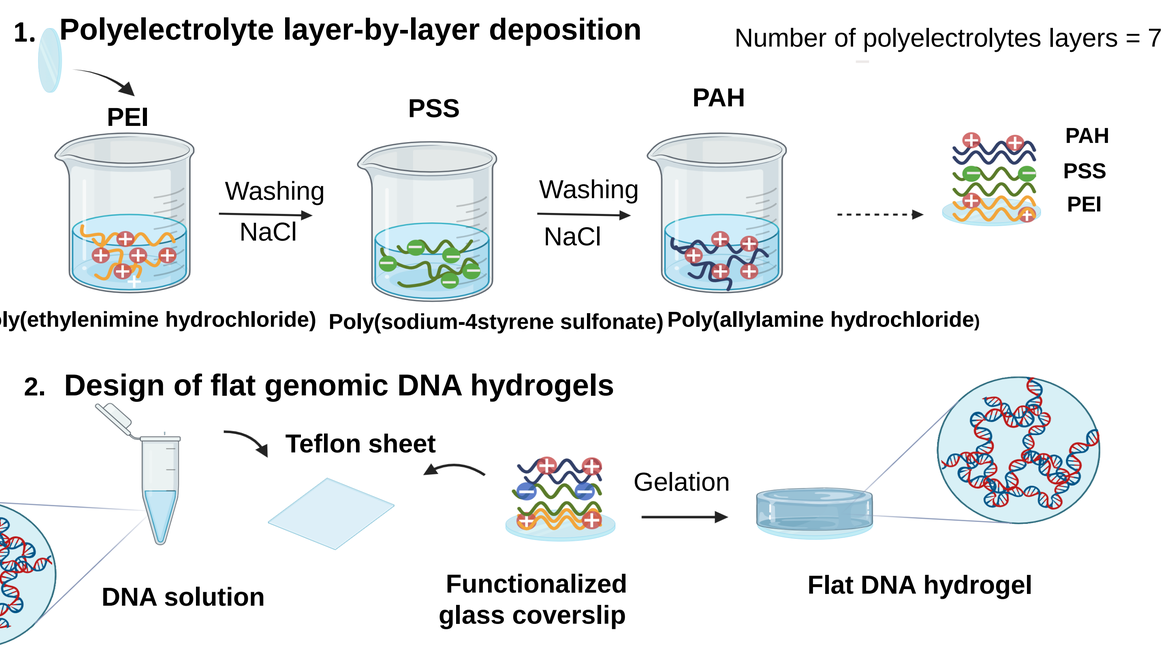


Scheme 1: Schematic representation of a DNA hydrogel for mechanobiology studies.

Design of genomic DNA hydrogels



Design of flat genomic DNA hydrogels



Preliminary results

1. Chiroptical properties of genomic DNA in aqueous solution

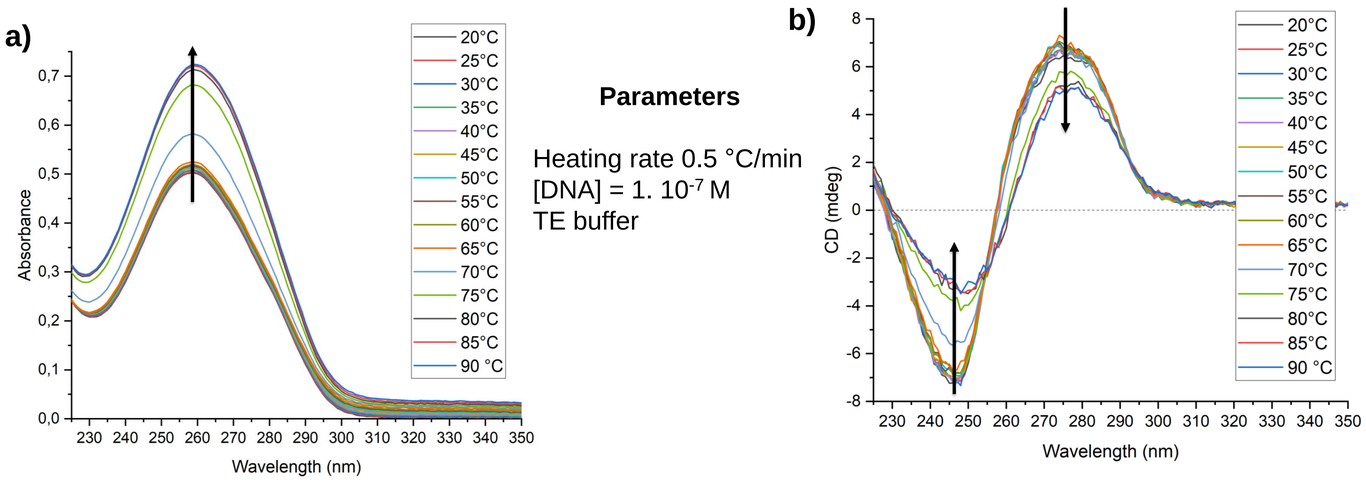


Figure 1: a) UV-Vis and **b)** CD temperature-ramping experiments for salmon DNA in aqueous solution

- UV-Vis absorption of DNA increases when temperature increases
- Double-strand DNA ⟶ Single-strand DNA

Hyperchromic effect

- CD signal of DNA decreases when temperature increases
- Double-srand DNA ⟶ Single-strand DNA

Reduction of excitonic coupling

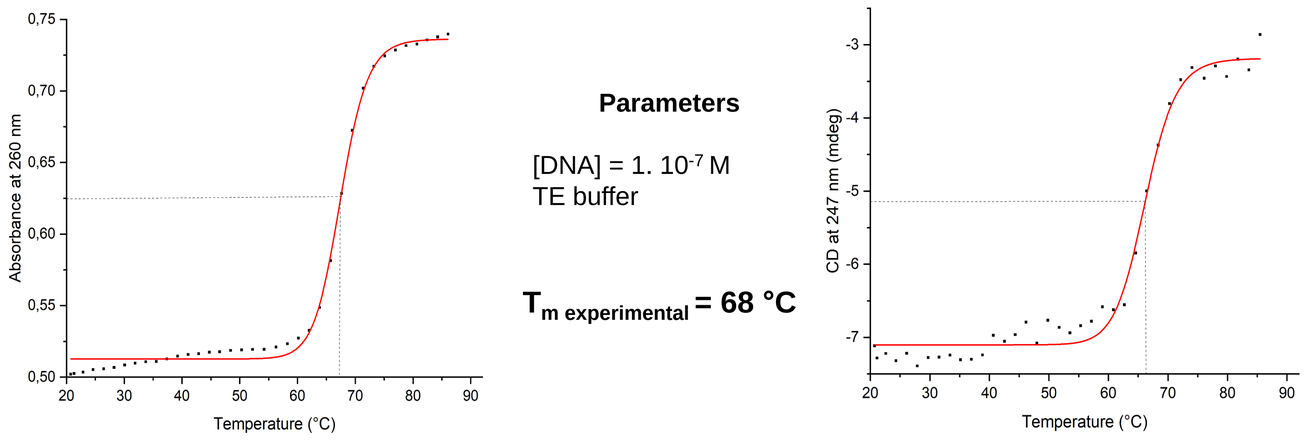


Figure 2: a) Maximum absorbance as a function of temperature. **b)** The maximum of the negative CD peak as a function of temperature.

Sigmoidal curves ⟶ Cooperative effect

2. Chiroptical properties of genomic DNA in gel state

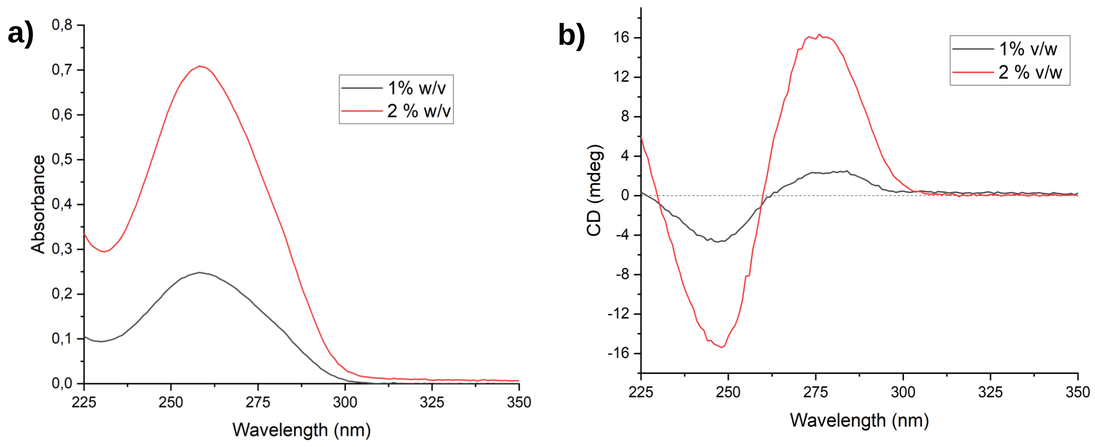


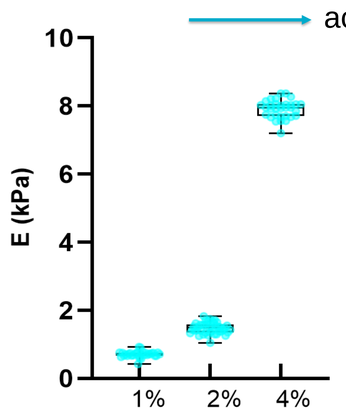
Figure 3: a) UV-Vis and **b)** CD spectra of salmon DNA in gel state.

⟶ Absorption and CD spectra of DNA are similar in solution and in gel state

3. Local mechanical properties of DNA hydrogels

Nanoindentation experiments on salmon DNA hydrogels

⟶ access to the Young modulus (E)



- Varying the concentration of DNA results in hydrogels with modulable mechanical properties

1% w/v 2% w/v ~ 1 kPa
4% w/v ~ 8 kPa
⟶ **promising for the study cell mechanobiology**

- E measurements are reproducible for the same type of hydrogel

Figure 4: Individual E measured for DNA hydrogels at different concentrations.

Conclusion and outlook

➢ Similar chiroptical and mechanical characterization of another DNA from herring have been performed.

➢ The obtained hydrogels are promising scaffolds to study cell migration with modular mechanical properties of the substrate

References

1. U. Blache, E. M. Ford, B. Ha, L. Rijns, O. Chaudhuri, P.Y.W Dankers, A. P. Kloxin, J. G. Snedeker and E. Gentleman, *Nat Rev Methods Primers 2*, **2022**, 98.
2. J. Gačanin, C. V. Synatschke and T. Weil, *Adv Funct Materials*, **2020**, 30, 1906253.

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