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Karlsruhe Institute of Technology (KIT), Germany

MY RESEARCH INTERESTS LIE AT THE INTERFACE OF SOFT MATTER PHYSICS AND BIOPHYSICS, WHERE THE HIERARCHICAL SELF-ASSEMBLY AND SELF-ORGANISATION OF SIMPLE BUILDING BLOCKS LEADS TO THE FORMATION OF COMPLEX FUNCTIONAL NETWORKS. IN PARTICULAR, THROUGH INVESTIGATING THE MECHANICAL PROPERTIES OF SMART PROGRAMMABLE MATERIALS, MY LAB AIMS TO PROVIDE ANSWERS TO THE QUESTION OF HOW LOCAL MICROSCOPIC INTERACTIONS GIVE RISE TO THE EMERGENCE OF COMPLEX MACROSCOPIC BEHAVIOUR.

TO THIS END, DNA HYDROGELS PRESENT US WITH AN IDEAL MODEL SYSTEM, WHERE WATSON-CRICK BASE PAIRING RULES ENSURE HIGH DEGREE OF PROGRAMMABILITY AND PREDICTABILITY IN THE INTERACTIONS BETWEEN DNA BUILDING BLOCKS. AKIN TO USING SMALL UNITS OF LEGO BRICKS, ONE CAN

SYNTHESISE AND DEPLOY RATIONALLY DESIGNED SHORT OLIGOMERS IN ORDER TO ARRIVE AT HIGHER-ORDER STRUCTURES THAT ARE BUILT UPON DIFFERENT MODES OF CONNECTIVITY AND THEREFORE POSSESS DIFFERENT PROPERTIES. THIS APPROACH LIES AT THE HEART OF DNA NANOTECHNOLOGY, WHICH WAS PIONEERED AS A FIELD IN THE EARLY 90S BY NADRIAN SEEMAN.

EVER SINCE, DNA ORIGAMI AND DNA SELF-ASSEMBLING HYDROGELS HAVE ATTRACTED SIGNIFICANT ATTENTION BY PROVIDING ADVANCED ALTERNATIVES TO WIDELY UTILISED MATERIAL SOLUTIONS, SUCH AS POLYURETHANE FOAMS AND MATRIGEL, WHOSE APPLICATION RANGE AND FUNCTIONALITY REMAIN LIMITED BY THE LACK OF CONTROL OVER THEIR MECHANICAL PROPERTIES. LEVERAGING THE LATEST DEVELOPMENTS IN CUTTING-EDGE OPTICAL TOOLS AND THE SUBSTANTIAL PROGRESS IN THE FIELD OF MICRORHEOLOGY, WE ARE

NOW BETTER POSITIONED THAN EVER TO ADDRESS OUTSTANDING QUESTIONS RELATED TO THE INTERDEPENDENCE BETWEEN STRUCTURE AND FUNCTION. INSIGHTS IN THIS AREA ARE EXPECTED TO PROMOTE ADVANCEMENTS IN MATERIALS SCIENCE AND MECHANOBILOGY.

EDUCATION

2016-2020 Doctor of Philosophy in Physics (PhD)

Department of Physics, University of Cambridge, United Kingdom

Thesis Title: Broadband Rheological Characterisation of Soft Functional Materials ([link to my PhD Thesis](#))

Thesis Supervisor: Prof. Erika Eiser (formerly at University of Cambridge, now at NTNU's PoreLab in Trondheim)

Thesis Examiners and Thesis Outcome: Prof. Paul Bartlett (Bristol) and Dr. Tijmen Euser (Cambridge), Outright Pass



2011-2016 Integrated Master's Degree in Chemical Physics (MChemPhys)

Department of Chemistry, University of Edinburgh, United Kingdom

Thesis Title: Compositional Ripening of Droplets in a Three-Phase Liquid System

Thesis Supervisor: Prof. Paul Clegg

Thesis Outcome: Best Master's Project Award

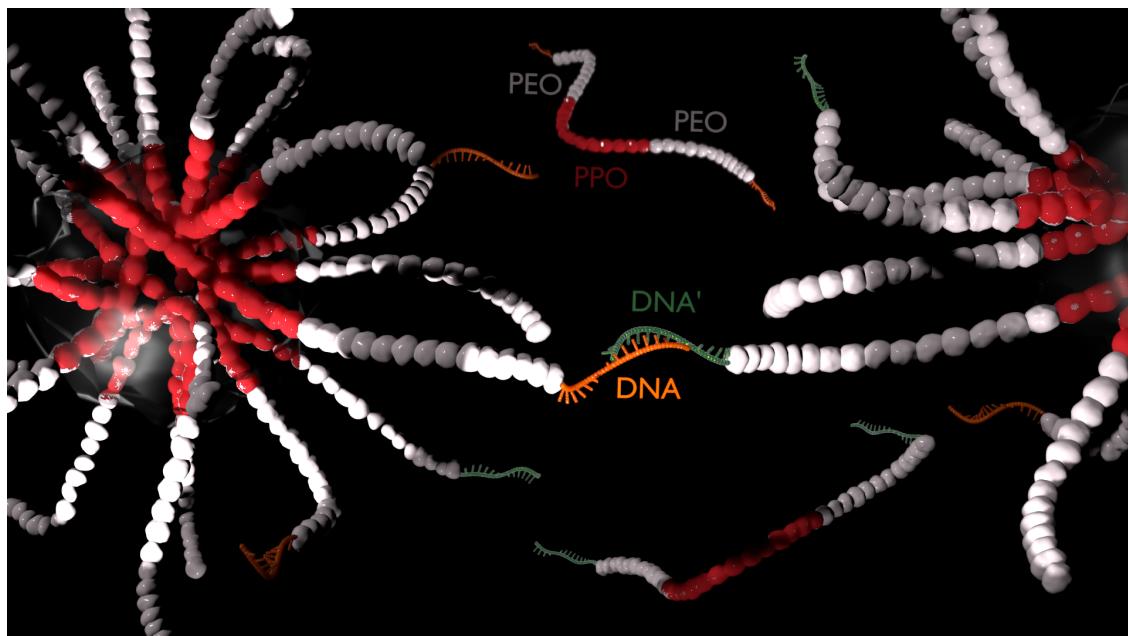


CURRENT RESEARCH

As YIG Prep Pro fellow at IBCS-BIP (KIT) my lab's efforts are directed towards the generation of a library of biocompatible and mechanically tunable DNA self-healing networks, the properties of which can be linked to specific

materials science applications. So far, individual attempts have focussed on the selection of certain programmable DNA hydrogels for fulfilling a specific function, proving their versatile functionality as metamaterials, drug-delivery and biosensing platforms. However, the lack of a detailed systematic investigation into the mechanics of these networks has prevented the establishment of an empirically informed scaling law relating the composition of the constituting DNA sequences to the mechanics of the overall hydrogel network that is formed as a result of self-assembly. The main reason for this gap in knowledge is the relatively high cost associated with DNA synthesis and the need to overcome technical obstacles, such as the artefact-free conversion of particle dynamics into mechanical properties. We endeavour to combine *in-silico* numerical screens and *in-vitro* microrheology experiments in order to efficiently sample the complex phase diagram presented by the hierarchical assembly of DNA oligomers, where the latter are rationally designed to yield mechanically different smart networks. Fulfilling this goal is anticipated to mark a substantial advancement to the field of DNA

nanotechnology and provide insights that are readily transferrable to other ‘patchy’ colloidal systems, where microscopic interactions govern the resulting phase behaviour on the macroscale.

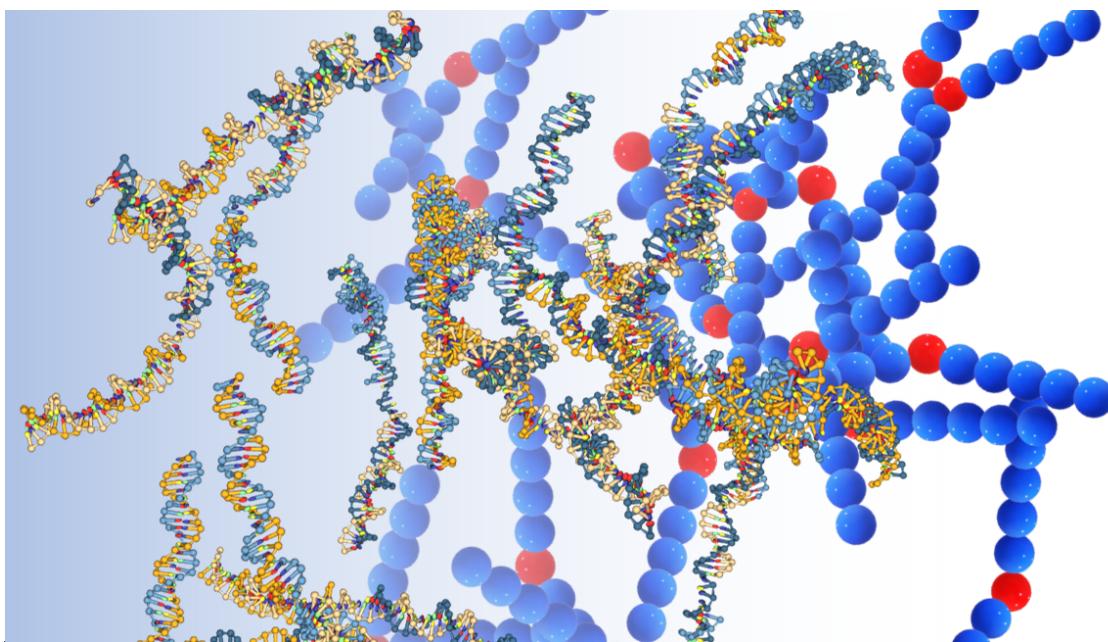


PREVIOUS WORK

Assessment of Formulation Stability and Spray Retention (Syngenta)

I built a coarse-grained simulation model with temperature-sensitive hydrophobic monomers to study the structure and phase behaviour of a symmetric bead-spring model for the PEO-PPO-PEO polymers. Further, we extended our model

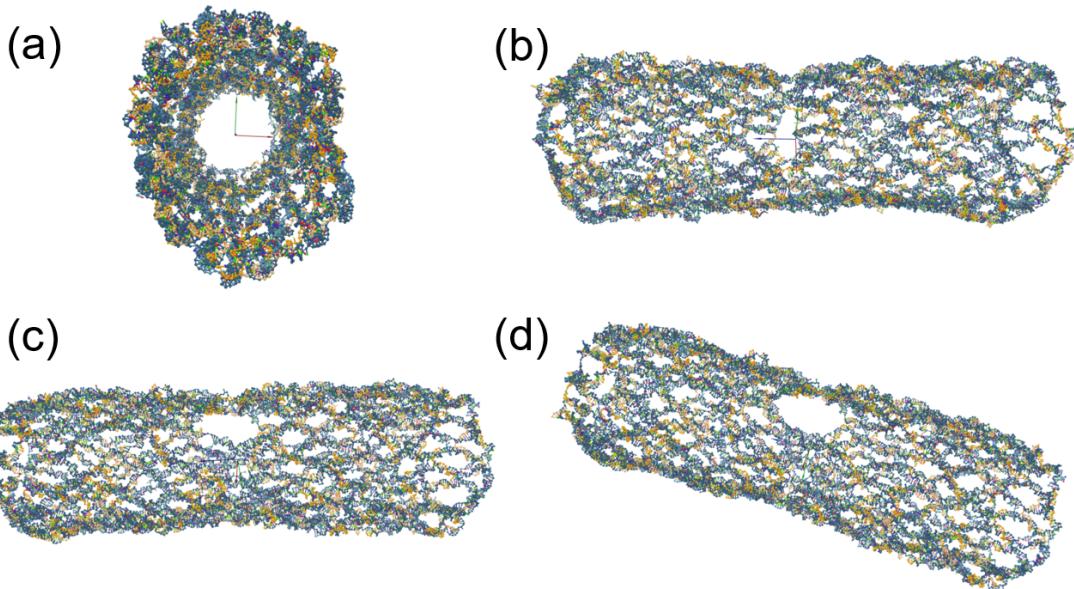
by adding a sticky patch to each free PEO chain, thus mimicking the complementary DNA sticky ends. This stickiness provides an additional, temperature dependent driving force for aggregation between two chain ends at low temperatures.



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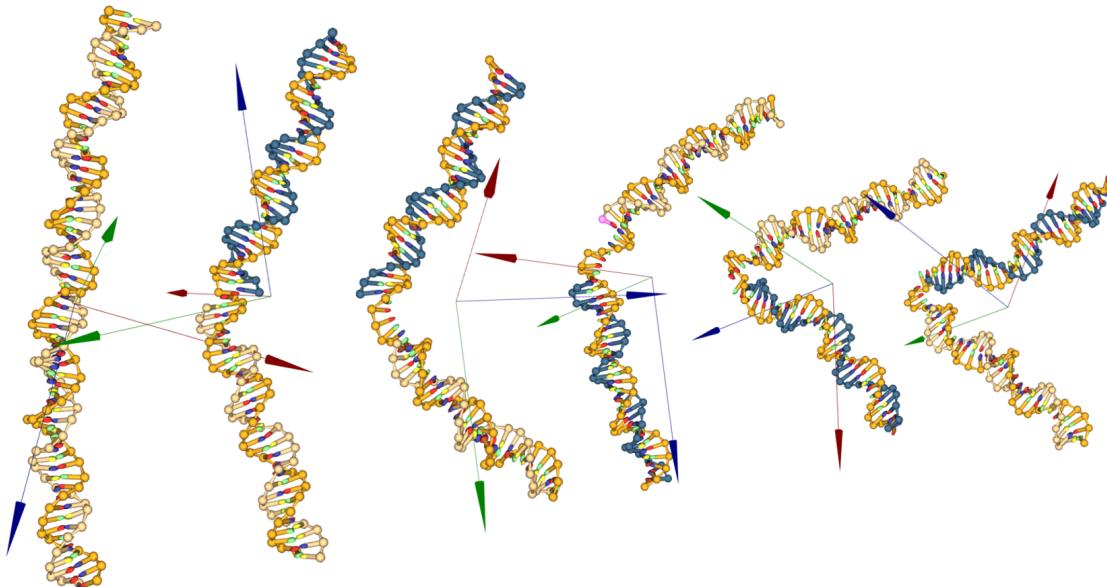
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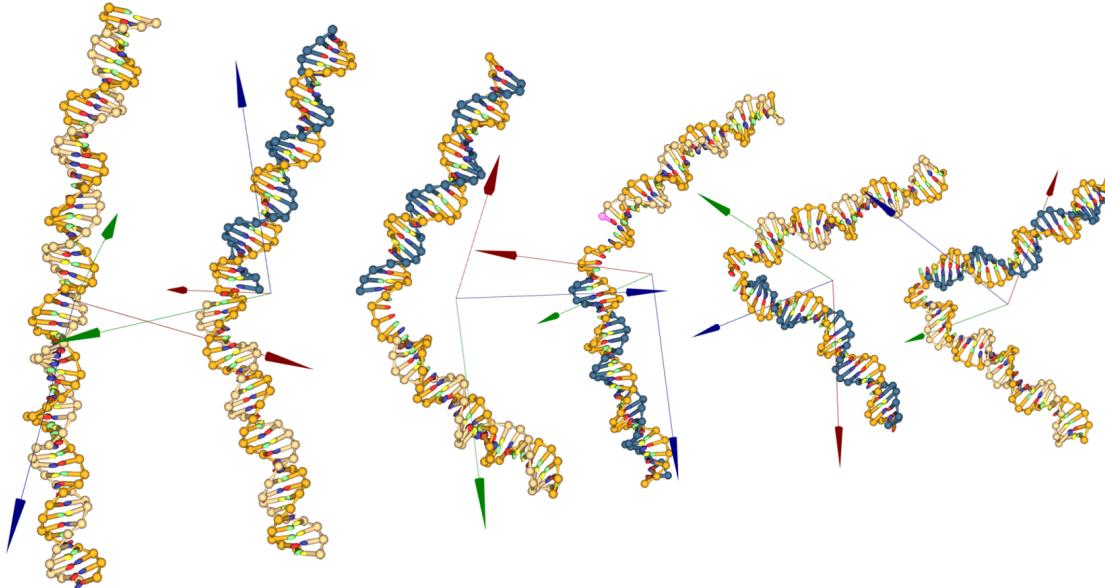
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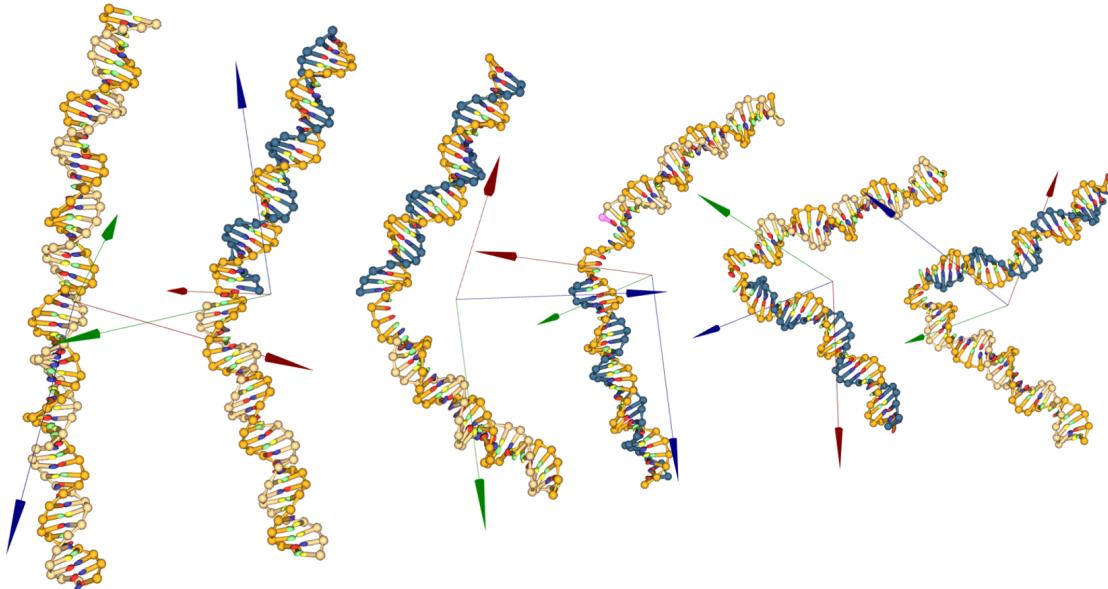
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