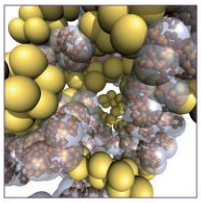

Physical Aspects of Polymer Science
8–10 September 2015
Manchester Institute of Biotechnology
Manchester, UK
http://paps15.iopconfs.org

Tuesday 8 September, Session 1, 13:30 – 14:15

(invited) **Single molecule studies of proteins from extremophile organisms**

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Extremophilic organisms, or extremophiles, have the remarkable ability to survive and thrive in environments that are considered to be extreme in terms of temperature, pressure, salinity, pH, radiation, or having low levels of oxygen or nutrients. These organisms and their constituent biological components have enormous potential for applications in biotechnology, including bioremediation, healthcare and energy production. For micro-organisms, the adaptations usually occur at the molecular level and proteins expressed by extremophiles are of considerable interest as they are able to retain their fold and function in extreme conditions. Proteins from different extremophiles therefore offer excellent model systems to test our understanding of the origins of protein stability.

Using a combination of protein engineering, biophysical characterization, single molecule force spectroscopy (SMFS) and molecular dynamics (MD) simulations we have examined proteins from a range of different extremophiles including; hyperthermophiles that are adapted to high temperatures (having an optimal growth temperature, T_{OPT}, above ~ 80°C), psychrophiles that are adapted to cold temperatures (T_{OPT}, below ~ 20°C) and halophiles that are adapted to high salt concentrations (2- 5M salt). We have measured the impact of noncovalent interactions on protein stability and flexibility; including salt-bridges, hydrogen bonds, hydrophobic interactions and loop flexibility.

Informed by these studies we have designed novel proteins which exhibit mechanical robustness and malleability, through the incorporation of specific molecular features identified in the extremophilic proteins. These studies are providing a deeper understanding of the adaptations found in extremoophilic proteins, and are enabling the rational design of proteins for bionanotechnological applications.

[1] Tych KM; Hoffmann T; Batchelor M; Hughes ML; Kendrick KE; Walsh DL; Wilson M; Brockwell DJ; Dougan L Life in extreme environments: single molecule force spectroscopy as a tool to explore proteins from extremophilic organisms BIOCHEMICAL SOCIETY TRANSACTIONS 43, 179-185, 2015

[2] Tych KM; Hughes ML; Bourke J; Taniguchi Y; Kawakami M; Brockwell DJ; Dougan L Optimizing the calculation of energy landscape parameters from single-molecule protein unfolding experiments Physical Review E - Statistical, Nonlinear, and Soft Matter Physics 91,12710- 12718, 2015

[3] Tych KM; Hoffmann T; Brockwell DJ; Dougan L Single molecule force spectroscopy reveals the temperature-dependent robustness and malleability of a hyperthermophilic protein Soft Matter 9, 9016-9025, 2013 Hoffmann T; Tych KM; Hughes ML; Brockwell DJ; Dougan L Towards design principles for determining the mechanical stability of proteins. Phys Chem Chem Phys 15 15767-15780, 2013