rality. This homochiral evolution hence sheds light on the transfer mechanisms that link chiral structure across these length scales in self-assembling materials. (Reposted by Rong-Ming Ho, National Tsing Hua University)

*This report features the work of Rong-Ming Ho, Jing-Cherng Tsai and their collaborators published in Proc. Natl. Acad. Sci. USA **116**, 4080 (2019).*

TLS 23A1 IASW – Small/Wide Angle X-ray Scattering

- SAXS
- Soft Matter, Block Copolymers, Self-assembly, Chirality

Reference

1. H. F. Wang, K. C. Yang, W. C. Hsu, J. Y. Lee, J. T. Hsu, G. M. Grason, E. L. Thomas, J. C. Tsai, R. M. Ho, Proc. Natl. Acad. Sci. USA **116**, 4080 (2019).

Transfromer: Self-Healing Hydrogels

Smart structures of hydrogels can automatically repair damage in varied environmental conditions according to actuation properties.

Self-healing hydrogels are artificial substances with three-dimensional networks, which have built-in smart structures to allow automatic repair of damage to themselves with neither external diagnosis of the problem nor human intervention. Self-healing hydrogels can thus adapt to varied environmental conditions according to their sensing and actuation properties, because they contain reversible dynamic bonds, such as hydrogen bonds, Schiff base, Diels–Alder reaction, boronate ester bonds, host–guest chemistry, hydrophobic interactions, ionic interactions and metal–ligand coordination. Hydrogels are able to absorb water or biological fluids in large proportions, and thus have the advantages of biocompatibility, biodegradability, injectablity and porous structure to be utilized as soft scaffolds for cells in tissue engineering and for surgical operation in a minimally invasive way. Because of their poor mechanical strength and the fragile nature of the hydrogels, the feasibility of applying these hydrogels is, however, still limited. Hydrogels with desirable chemical compositions and tunable mechanical strength have been designed with various synthetic strategies.

Shan-Hai Hsu (National Taiwan University) and her collaborators has devoted to an investigation in the fields of biomaterials, polyurethane, tissue engineering and nanomaterials. Recently, that group reported chitosan-based hydrogels with an ability of self-healing for biomedical applications.[1] Chitosan is generally nontoxic, biocompatible, biodegradable and bacteriostatic, satisfactory for utilisation in many pharmaceutical and medical applications. The observation of macroscopic self-healing of the hydrogels is shown in **Fig. 1**. The cut semi-disc pieces of the hydrogels can merge into an integrated circular piece of the

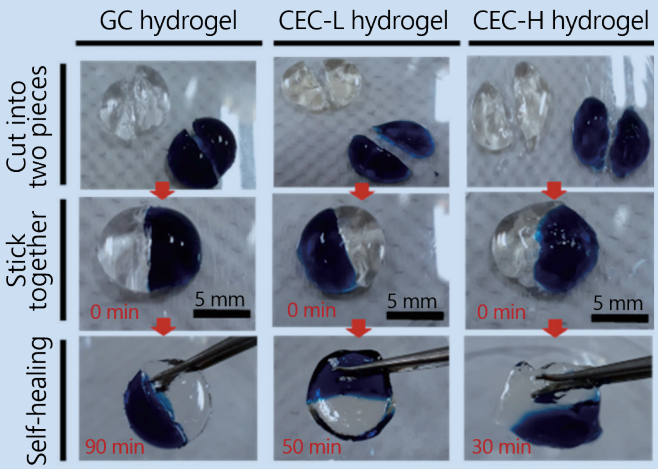

Fig. 1: Glycol chitosan (GC) and N-carboxyethyl chitosan (CEC) were cut into two pieces and stuck back next to each other. All hydrogels later recovered their shape and could be picked up with tweezers without breaking, showing the self-healing behavior. [Reproduced from Ref. 1]

hydrogels and recover the mechanical stability after several decade minutes. All healed hydrogels could be picked up and shaken with tweezers without breaking, indicating that the self-healing hydrogels retain great strength. The workers utilized small-angle X-ray scattering *in situ* combined with a rheometer (Rheo-SAXS) at **TLS 23A1** and ultra-small-angle X-ray scattering (USAXS) at **TPS 25A** to probe the structure of the hydrogels and their dynamics. From the SAXS results (**Figs. 2(a), 2(c) and 2(e)**), the hydrogels show a typical mechanism of nucleation and growth for the three chitosan-based hydrogels. The critical nucleation sizes of the three hydrogels were observed from the SAXS profiles. The time-resolved

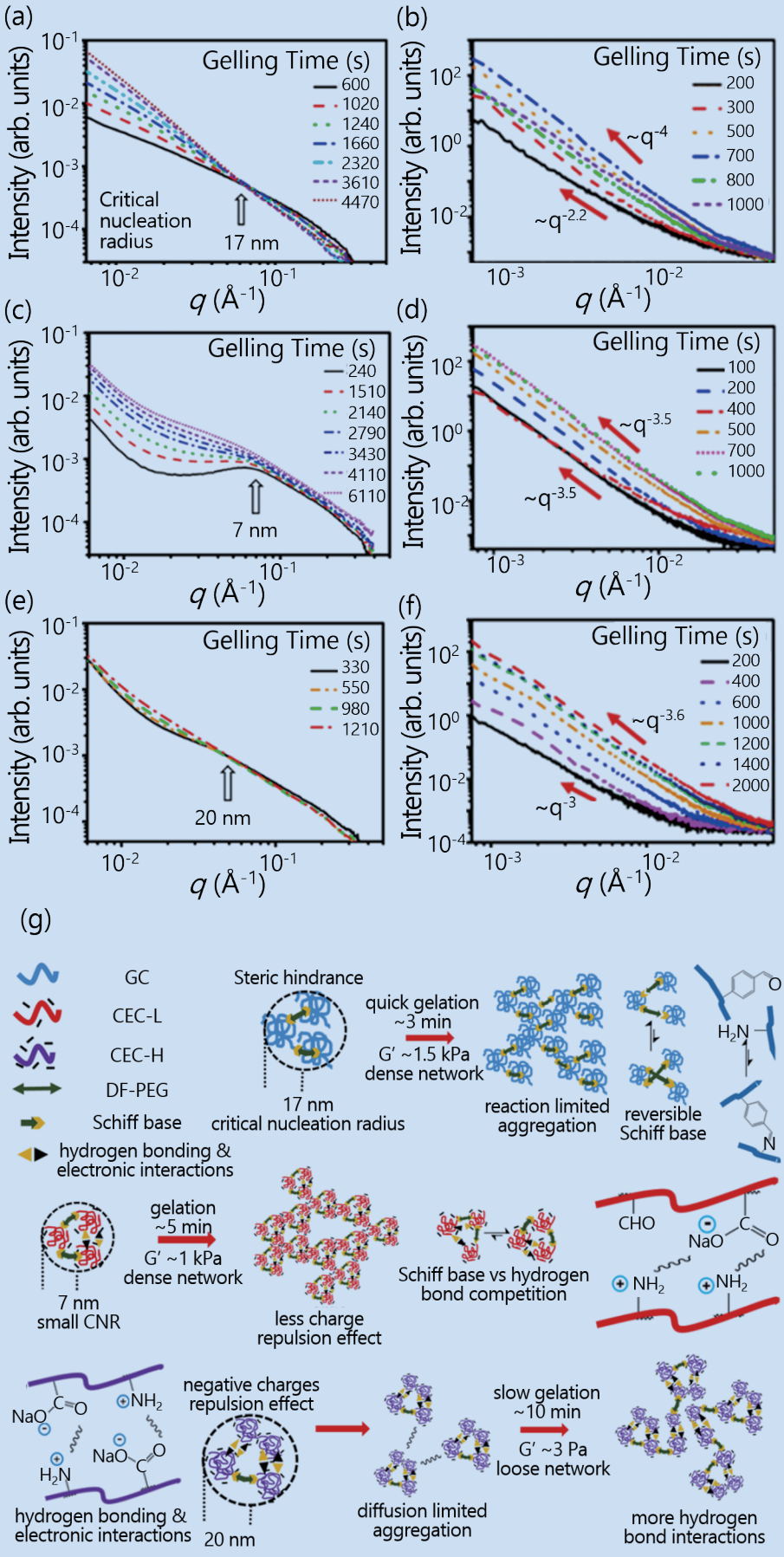

Fig. 2: SAXS and USAXS profiles for (a)–(b) GC hydrogel, (c)–(d) CEC-L hydrogels and (e)–(f) CEC-H hydrogel. (g) Schematics for the gelation mechanisms of various self-healing hydrogels. [Reproduced from Ref. 1]

USAXS profiles revealed that the various hydrogels feature varied fractal structures and aggregation behaviors (**Figs. 2(b), 2(d) and 2(f)**). The reaction-limited aggregation is affected by the Schiff reaction from the amino groups and aldehyde groups of the glycol chitosan (GC) hydrogels, whereas the diffusion-limited aggregation is attributed to the formation of hydrogen bonds and negative charges in the N-carboxyethyl chitosan (CEC) hydrogels. A hypothetical model of nucleation and growth for the chitosan self-healing hydrogels is illustrated in **Fig. 2(g)**. (Reported by Shan-Hai Hsu, National Taiwan University)

This report features the work of Shan-Hai Hsu and her collaborators published in ACS Macto Lett. ***8****, 1449 (2019).*

TPS 25A Coherent X-ray Scattering

TLS 23A1 IASW – Small/Wide Angle X-ray Scattering

- SAXS, USAXS
- Soft Matter, Chemistry, Hydrogels

Reference

1. Y. J. Lin, W. T. Chuang, S. H. Hsu, ACS Macro Lett. **8**, 1449 (2019).