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# Over-Swelling Induces Osmotic Explosion of Polymer Network Gels

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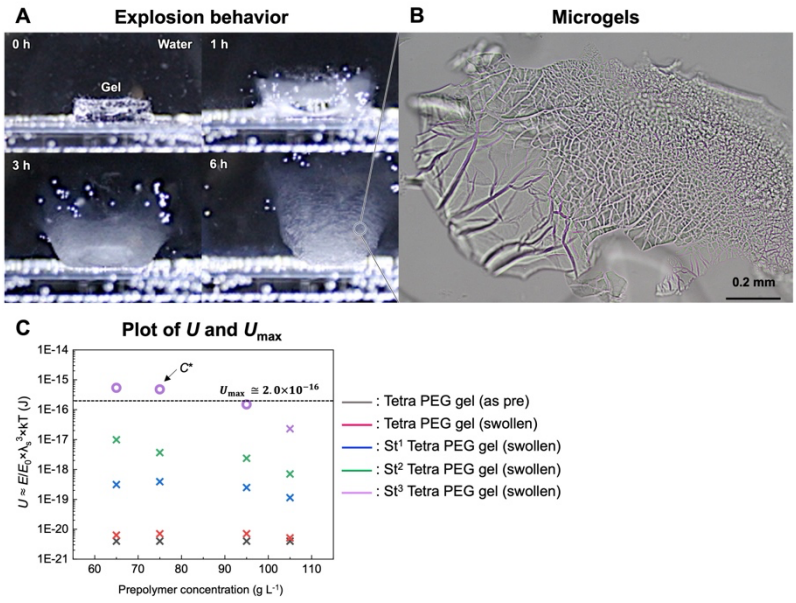
A polymer network soaked in its solvent absorbs the solvent molecules. This phenomenon is well known as a swelling. Here, there is a simple but quite fascinating question. “Can a gel network swell in solvent until it reaches to the structural limit?” To address this question, we adopt the simple but reasonable assumption that the structural swelling limit of a gel is dictated by the extensibility of its network strands. Under this assumption, the structurally possible swelling range of a polymer network is from its dried state to the structural swelling limit where its network strands reach their stretching limit. However, swelling of a polymer network to near its structural limit has not been realized due to the thermodynamic limitation[1]. Here, we broke the limitation and succeeded in excessive swelling of polymer networks to or even beyond their structural swelling limit. For the excess swelling, we repeatedly introduced dense linear polymers inside a polymer network of interest(Hereafter referred to St gel). The linear polymers, trapped inside the polymer network, generate extremely high osmotic pressure and make the polymer network swell excessively[2]. The resulting polymer networks over-swollen beyond their structural limit disintegrated into microgels due to catastrophic scission of the network strands, analogous to osmotic hemolysis of red blood cells in a hypotonic solution (Fig.1A, B). Also we found the criteria of the bulk disintegration from the elastic energy per a single polymer network strand. When the bulk disintegration occurred, following equation is held; $U \geq U_{max}$ (Fig.1C). Here, $U$ is the storage elastic energy per a single polymer network strand estimated from the elastic modulus, and $U_{max}$ is the maximum energy that a single polymer network strand can withstand calculated based on the bond dissociation energy.




*References:*
[1] *Quesada-Pérez M.et al., Soft Matter* ***7****, 10536–10574 (2011).*
[2] *Tasuku Nakajima et al., Adv. Funct. Mater.* ***22****, 4426–4432 (2012).*