Novel library of degradable hydrophilic homopolymer *N*-methylated nylons

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Nylon-*p,q*, the first synthetic fiber invented by Carothers, was developed by constructing a systematic polymer library with varied carbon numbers (*p,q*) in the backbone[1]. Nylon is practically insoluble in water because the secondary amide group in polymer backbones forms a hydrogen bond network between the polymer chains. However, research on *N*-methylated nylons was never pursued further because of their unsuitable low crystallinity for fiber applications. If the hydrogen bond network could be disrupted, amide groups could be directed to form hydrogen bonds with water molecules preferentially, leading the utility in solution. Therefore, the role of the amide group would convert into acting as a hydrophilic group.

Herein, we revisit *N*-methylated nylon-*p,q* as a novel class of degradable hydrophilic homopolymers (Figure 1)[2]. Following the strategy for developing nylon-*p,q*, we constructed a library of 24 types of *N*-methylated nylon-*p,q*, enabling fine-tune of water solubility from soluble to insoluble by varying the carbon number (*p,q*). *N*-methylated nylon-*p,q* with optimal hydrophilic /hydrophobic balance exhibited lower critical solution temperature (LCST)-type phase separations with the formation of coacervate droplets. Furthermore, *N*-methylated nylons showed the durability under neutral conditions and on-demand degradability under acidic conditions through the hydrolysis of the amide groups. These advantages would address the environmental concerns for polymer wastes with low degradability. Simple *N*-methylation of nylons transforms from a fiber to hydrophilic polymers that satisfied the modern societal demands.

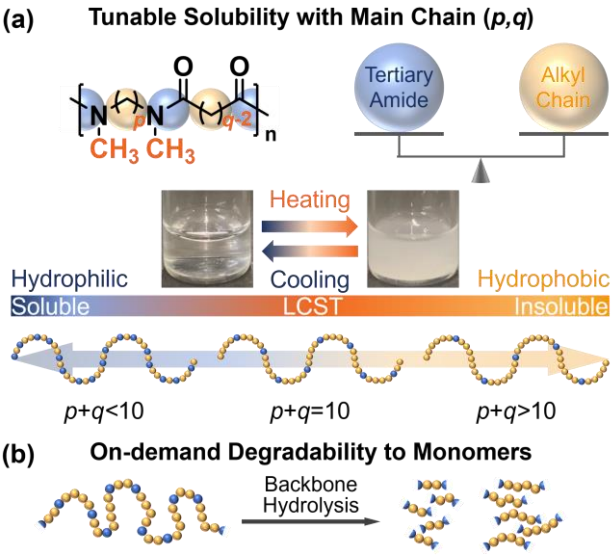

Figure 1. (a) Tuning the water-solubility of *N*-methylated nylon-*p,q* by varying carbon numbers (*p,q*) in the polymer backbone. The blue and orange spheres represent the hydrophilic tertiary amide group and hydrophobic alkyl chain in the polymer backbone, respectively. (b) On-demand degradation of the polymer chain to monomers through the acidic hydrolysis of an amide group in the polymer backbone.

1) Carothers, W. H. US2130523A, **1938**.
2) Sugano, A.; Inaba, N.; Matsuoka, K.; Sada, K. *ChemRxiv* **2024**, DOI: 10.26434/chemrxiv-2024-f93fr