Dynamic DNA Self-Assembly based Nucleic Acids Sensing

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Based on the thermodynamics of the hybridization-based DNA self-assembly principle, exciting progresses in enzyme-free synthesis of DNA nanostructures have been made [1-2]. In the presence of a single-stranded DNA (i.e., a catalyst strand), the partial complementarity between the catalyst DNA and the loop domain of the DNA (the internal toehold) lowers the free energy and improves the reaction kinetics. Using the idea of "catalyst" strand to control the DNA assembly rate, the hybridization chain reaction (HCR) was introduced by Dirks and Pierce where a linear-branched DNA polymer could be assembled in a way similar to the radical-initiated polymerization process. An initiator strand, acting like a radical, triggers autonomous linear extension of originally stable hairpin DNA pairs and leads to an amplified HCR DNA product of high molecular weight [3]. This process requires no enzyme and the amplification triggered by a DNA sequence or aptamer has attracted many researchers' interest in using this approach for sensitive sensing.

We have recently reported a new non-linear version of the HCR process, which could potentially offer sensitivity comparable with PCR and higher than that of the HCR [4]. We have also demonstrated an electrochemical version of sensing strategy based on this highly branched growth of dendritic DNA/PNA [5]. New substrate-sequence design strategies that can achieve high detection sensitivity with minimized reaction leakage will be delineated.

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