Development of a Self-Viscosity and Temperature-Compensated Technique for Highly Stable and Highly Sensitive Bead-Based Diffusometry

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1. Decomposition of Blinking Signal by Hilbert Huang Transform

To reduce the blinking signal noise, the blinking signal was decomposed by "Hilbert Huang Transform (HHT)" to get proper signal. A powerful algorithm "Empirical Mode Decomposition (EMD)" proposed by N. E. Huang was used for decomposing the nonlinear and non-stationary blinking signal into "Intrinsic Mode Functions (IMFs)", which demonstrate instantaneous frequency data [1,2].

Since the IMFs correspond to different frequency, it is required to nail down the right IMF. Thus, the cross-correlation algorithm was applied to determine the similarity of IMFs and original blinking signal [3]. The correlation peak in correlation pattern was then used to stand for the similarity of IMF with original blinking signal. The highest similarity of IMF was analyzed by fast Fourier transform to calculate the blinking frequency. The blinking frequency was final define by the maximum value of Gaussian curve fitting.

2. Estimation of Small Particles Conjugated with Janus Particles

To estimate the appropriate concentration of small particles to be used, a total gold surface area of large Janus particles was firstly calculated. Under the ideal assumption of being fully covered by antibodies (12 nm x 12 nm), the maximum number of 500 nm PS particles was around 6 with the gold surface area of a single Janus particle to be 1.57×10^{-12} m^2 and the projected area of a single PS particle to be 2.5×10^{-13} m^2. With the estimation, 10 μL of 0.5 mg/mL capture antibody was required to mix with 20 μL of Janus particles (4×10^7 #/mL). Under this condition, the overall diameter of one 500 nm PS particle conjugated with a 1-micrometer Janus particle was 1.04 micrometer. However, the standard deviations of pure 1 micrometer Janus particles were 62 nm (from the measurement). Therefore, when two IFN-γ bound on the Janus particles the overall diameter of the immunocomplex could be estimated 1.08 micrometer.

3. Four-parameter exponential

This approximation is based on the empirical fitting. According to the reference[1], the formula is expressed as:

$$\eta = A \exp\left(\frac{B}{T} + CT + DT^2\right) \quad (1)$$

where A, B, C, and D are constants of water, which are experimentally determined to be1.86×10^{-11} mPa.s, 4209 K, 0.04527 K^{-1}, and -3.376×10^{-5} K^{-2}, respectively. Notably, A, B, C, and D are constants subjected to different solutions.

References

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