Ultrasensitive detection of biomarkers based on anisotropic gold nanorods and dark field imaging

Chaoshan Zhao[a] and Shunbo Li[a]

[a] Key Laboratory of Optoelectronic Technology and Systems, Ministry of Education, College of Optoelectronic Engineering, Chongqing University, Chongqing 400044, China.

The detection of tumor markers in body fluids is crucial for the screening, diagnosis, and prognosis analysis of cancer. Hence, the sensitivity of tumor biomarker screening is highly demanded in detection. Currently, several detection techniques are available, such as fluorescence analysis, surface-enhanced Raman scattering, electrochemical luminescence, and electrochemical analysis. However, these methods have certain limitations, such as low sensitivity, poor stability, complex processes, and long reaction time. In recent years, the imaging technique combined with precious metal and dark field microscopy has gained popularity in the field of highly sensitive biochemical detection due to its high spatiotemporal resolution and independence of signal reporter molecules. Gold nanorods (AuNRs) are anisotropic nanomaterials that show two types of plasmon - longitudinal plasmon resonance and transverse plasmon resonance, in which the longitudinal LSPR plays a dominant role in the detection, while the transverse LSPR mode is always neglected. Herein, polarized light which is perpendicular to the AuNRs is designed to stimulate the transverse plasma resonance of the AuNRs to detect biomarkers in microfluidic chip. In this work, Vascular Endothelial Growth Factor ($VEGF_{165}$) is used as the testing biomarker to demonstrate the feasibility of this method. With the presence of $VEGF_{165}$ in the sample solution, AuNRs will capture the gold nanoparticles due to the antibody-antigen-antibody switched structure, inducing the change of polarized plasma resonance property. This method achieves a detection limit of 10 pg/ml for $VEGF_{165}$, which is lower than most of the reported methods. The results show that the method based on the combination of a microfluidic chip and dark field microscopic image has excellent sensitivity and has significant potential in early cancer diagnosis and prognosis analysis.