

准确测量微藻生物量的塑料光纤倏逝波传感器

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Plastic optical fiber evanescent wave sensor for accurate measurement of microalgae biomass

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摘要 图/表 参考文献 相关文章 (15)

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摘要 为了准确测量微藻生物量,研制了新型倏逝波传感器。首先,采用研磨法制备了两根D形光纤,对D形区域进行升温-降温循环水浴处理后,将处理后的D形光纤制备成U形;然后,将其中一根U形光纤标记为传感器传感臂,用于测量藻液中细胞和液相变化信息;在另一根U形光纤表面包裹一层混合纤维素酯多孔微藻滤膜并标记为传感器参考臂,用于测量藻液中液相变化信息;最后,利用传感臂和参考臂构成双探针U形塑料光纤倏逝波生物量传感器。建立了传感器测量理论模型,测试了传感器性能参数及对生物量的响应特性。研究表明:传感器输出信号不受藻液中液相浓度及成分变化的影响,只与微藻生物量有关。该传感器能准确测量低浓度和高浓度微藻生物量,对于生物量为0~598.998 mg/L及吸光度(OD_{680 nm})为0~2.986的蛋白核小球藻,传感器测量值与拟合值之间的最大相对误差为2.46%,相对误差均值为1.28%。

关键词 : 塑料光纤, 光纤传感器, 倏逝波传感器, 双探针, 微藻生物量

Abstract : A plastic optical fiber sensor with double U-shaped probes (i.e. the sensor and reference probes) was created to accurately measure microalgae biomass. Firstly, two D-shaped fibers were created by a grinding method. The D-shaped fibers were subjected to numerous rounds of heating-cooling treatment to obtain U-shaped ones. One of the prepared U-shaped fibers was employed as the sensing probe and to sense the algal cells and changes in the liquid-phase (concentration and composition), and the other prepared U-shaped fiber coated with a hydrophilic mixed cellulose ester membrane was used as the reference probe to separate the liquids from the cells and to measure the liquid concentration and composition. Furthermore, the plastic optical fiber sensor with double U-shaped probes was implemented based on the sensing probe and the reference probe. A theoretical model was established to examine the performance parameters of the probes and the response properties of the sensor for the microalgae biomass. The measuring results show that the output signal of the prepared sensor is a function of the biomass and is not affected by changes in the liquid-phase composition or concentration. The developed sensor can accurately measure the low and high level biomasses. When the biomass of the chlorella pyrenoidosa in the range of 0-598.998 mg/L (the absorbance at OD_{680 nm} in the range of 0-2.986), the maximum relative error between the fitted curve and the experiment results is 2.46%, and the relative error mean is 1.28%.

Key words : plastic optical fiber optical fiber sensor evanescent wave sensor double probe microalgae biomass

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