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工程热物理

基于彩虹技术的吸收性液滴多参数测量方法

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摘要： 目前彩虹测量技术广泛地应用于液体参数的测量，然而针对吸收性液滴彩虹测量技术的研究较少。该文基于几何光学理论、Mie理论和Bouguer定律，提出一种同时测量液滴粒径、折射率和吸收率的多参数测量方法。利用电荷耦合器件图像传感器(charge-coupled device, CCD)相机拍摄液滴的彩虹信号，通过彩虹信号的Ripple结构频率、主峰峰值位置和强度，实现多参数测量。为避免自由下落液滴形成长短轴比随机的椭球而带来的测量误差，以毛细管出口的稳定液柱为测量对象进行实验研究。结果表明：若Ripple结构淹没在噪声之中，则无法准确获得频率，粒径的测量会产生较大误差；在Ripple结构信噪比较高的前提下，该方法具有较小的测量误差。红墨水溶液的吸收率与其浓度成线性关系，吸收率的测量下限可以达到10-5。

关键词： 彩虹技术　Mie理论　Bougure理论　吸收性　液滴

Multi-parameters Measurement for Liquid Column Based on Rainbow Technology

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Abstract: The rainbow technology is widely used for liquid parameter measurement. However there are few studies on liquid absorbance at present. A novel technique based on the geometrical optics, Mie theory and Bouguer law for measuring refractive index, radius and absorbance simultaneously was presented. A charge-coupled device(CCD) camera was used to detect the scattering intensity distribution arising from the liquid column illuminated by a laser beam. The frequency of Ripple bows, position and intensity of the maximum peak were used for multi-parameter calculation. Stable liquid column at the capillary export was chosen for experimental research to avoid the measurement error from nonsphericity of the falling droplets. The result shows that the frequency of Ripple bows couldn't be determined correctly when the Ripple bows are thoroughly destroyed by noise. Therefore the radius result has large error. On the contrary, accuracy result can be obtained when the signal to noise ratio of Ripple bows is high. A linear relationship between volume concentration of red ink and the absorbance is illustrated. And the lower detection limit of absorbance is as low as 10-5.

Keywords: rainbow technology　Mie theory　Bougure law　absorbance　liquid particle

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