

verter and linearizer 1343, then to a lock-in ratio amplifier 1344, where the amplitude of the signal is corrected for variations in the amplitude of the excitation beam detected by reference detector 1350, then to an analog-to-digital converter 1345, then to a digital display or signal processor 1345 and then to a digital storage or memory 1347.

If filter 1321 is constructed to pass the emitted fluorescence wavelength, then the device of the present invention measures fluorescence. If filter 1321 is constructed to pass the same wavelength as the excitation beam 1326, then the device measures the optical absorbance of the solution 1314.

In the event that it is desired that only fluorescence and not optical absorbance be measured, an alternative embodiment (not shown) may omit the chopper 1318 of FIGS. 8 and 12. In that event, light beam 1327A is merely trapped rather than being guided to filter 1321 and detector 1323. Fiber optic 1317, in such an embodiment, may be omitted and replaced with a light trap, or fiber optic 1317 may itself channel the light away from the flat plate wave guide 1316 as a light trap. Both the bulk fluorescence excited by light beam 1326B and the solution fluorescence excited by light beam 1326A generating an evanescent wave at the surface of the flat plate wave guide 1316 are transmitted over light path 1327B to filter 1321. Filter 1321 is selected to allow only the emitted fluorescent wavelength to pass through.

FIG. 13 illustrates yet another embodiment where the contents of housing 1360 are substituted for the contents of housing 1331 of the embodiment of FIG. 8. This embodiment is suitable for slow speed chopping of the light beams, for example, a few hertz or even fractions of a hertz. The chopping device viewed in the direction of arrow 14 is shown in FIG. 14. A flat plate 182 is affixed to a shaft 181, which is attached to a speed reducer clutch 183. The clutch 183 is attached to the shaft of reversible motor 184. A flat mirror 171 is attached to plate 182.

The plate 182 with mirror 171 attached is pivoted to swing between the position shown in FIG. 13 with solid lines or alternately the position shown with dashed lines. A stop 172 limits the travel of mirror 171 as the plate 182 abuts it and acts as a rigid point fixing the position of the mirror precisely again and again. Mirror 173 is similarly mounted for reciprocation and synchronized with mirror 171, generally as described with respect to the embodiment of FIGS. 8 and 12.

Having thus described my invention, what it is desired to protect by Letters Patent and hereby claim is:

1. A method for the optical analysis of a slurry, which slurry comprises:

- (a) a continuous phase which comprises a component that fluoresces at an optically detectable wavelength, and
- (b) a discontinuous phase which comprises a component that also fluoresces at said optically detectable wavelength,

the method comprising the steps of:

- (i) optically exciting said slurry with an evanescent wave having a wavelength that excites the fluorescence of said components and simultaneously
- (ii) detecting the intensity of the fluorescence resulting therefrom, and then
- (iii) relating said detected intensity of fluorescence to the concentration of said component in said continuous phase, such that said detected intensity of fluorescence is independent of the con-

centration of the component in said discontinuous phase that also fluoresces.

2. A method for the optical analysis of a slurry, which slurry comprises:

- (a) a continuous phase which comprises a component that fluoresces at an optically detectable wavelength, and
- (b) a discontinuous phase which comprises a component that also fluoresces at said optically detectable wavelength,

the method comprising the steps of:

- (i) optically exciting said slurry with an evanescent wave having a wavelength that excites the fluorescence of said components and simultaneously
- (ii) detecting the intensity of the fluorescence resulting therefrom, and at a different but nearby time
- (iii) illuminating the slurry with a non-evanescent wave and simultaneously
- (iv) detecting the intensity of the fluorescence or absorbance resulting therefrom, and then
- (v) determining the difference between the two intensity values, and
- (vi) relating said difference to the concentration of said component in said discontinuous phase, such that said difference is independent of the concentration of the component in said continuous phase that also fluoresces.

3. The method of claim 2 wherein the continuous phase comprises an aqueous solution in a bioreactor and the discontinuous phase comprises living cells.

4. The method of claim 3 wherein the fluorescence of NADH and NADPH are measured.

5. The method of claim 4 wherein the excitation beam is about 366 nm and the fluorescence is measured at about 460 nm.

6. Apparatus for determining the fluorescence or absorbance of the discontinuous phase of a system having a continuous phase which also fluoresces or absorbs light when excited or illuminated by light at an optically detectable wavelength emitted by the apparatus, comprising:

- (a) means for exciting the continuous phase with an evanescent wave at said wavelength, and
- (b) means for measuring the intensity of the fluorescence or absorbance resulting from the excitation of the continuous phase, and
- (c) means for illuminating the system with a non-evanescent wave at said wavelength, and
- (d) means for measuring the intensity of the fluorescence or absorbance resulting from the illumination of the system, and
- (e) means for comparing an intensity measurement generated by one of the aforesaid measurement means with an intensity measurement generated by the other of the aforesaid measurement means and for generating an indication of the difference between them,

such that the value of said difference is related to the concentration of said component in said discontinuous phase, and such that said value is independent of the concentration of the component in said continuous phase that also fluoresces.

7. Apparatus of claim 6, further comprising:

- (f) means for deactivating said evanescent wave excitation means (a) before activating the measurement means (d) and for deactivating said illumination