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Gulati et al.

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(54) **SYSTEMS AND METHODS FOR BLOOD GLUCOSE AND OTHER ANALYTE DETECTION AND MEASUREMENT USING COLLISION COMPUTING**

(71) Applicant: **Zyomed Corp.**, Altadena, CA (US)

(72) Inventors: **Sandeep Gulati**, La Canada Flintridge, CA (US); **Timothy L. Ruchti**, Gurnee, IL (US); **William Van Antwerp**, Valencia, CA (US); **John L. Smith**, Portland, OR (US)

(73) Assignee: **Zyomed Corp.**, Altadena, CA (US)

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CPC G01N 21/359; G01N 33/491; G01N 2201/1228; G01N 2201/1232; G01N 2201/129
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,638,640 A 2/1972 Shaw
3,761,921 A 9/1973 Adler et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CA 2337097 A1 1/2000
CA 2454894 A1 7/2004
(Continued)

OTHER PUBLICATIONS

Amerov AK et al., 'Method and Device for Non-Invasive Blood Glucose Measurement,' Proc SPIE 3599, Optical Diagnostics of Biological Fluids IV, May 17, 1999, San Jose, California, USA, 3599:33-42.
(Continued)

Primary Examiner — Kiho Kim
(74) *Attorney, Agent, or Firm* — Goodwin Procter LLP

(57) **ABSTRACT**

In a noninvasive system for detection/measurement of glucose and other analytes in a medium such as tissue, illumination is directed to the medium and corresponding radiation from the medium is collected. Spectral energy changes associated with fragment(s)/feature(s) obtained from the collected radiation are determined using collision computing. Such spectral energy changes generally represent analyte concentration. The illumination is controlled to target a particular volume of the medium and/or such that the spectral energy changes become directionally monotonic with respect to analyte concentration. The illumination parameters include: intensity, wavelength, bandwidth, focal length, and/or duration of illumination, location and/or a size of an illuminated spot on the medium surface, depth at which the illumination can reach below the medium surface, spacing between the illuminated spot and a spot on the medium surface from which radiation is collected, and angle of the illumination relative to the medium surface.

30 Claims, 207 Drawing Sheets