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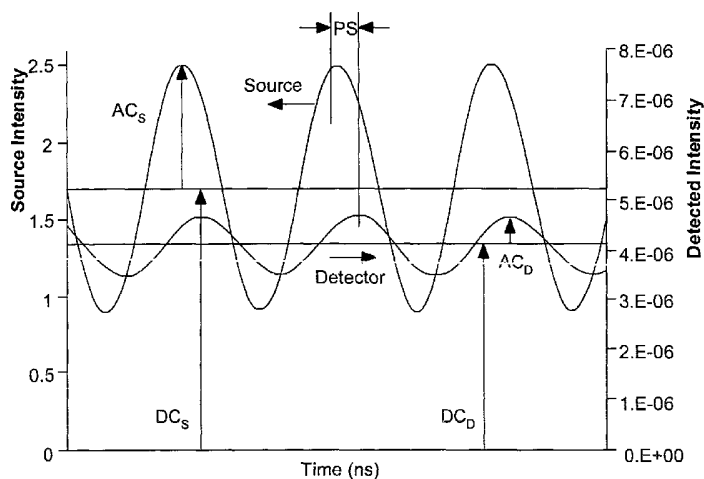
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[Continued on next page]

(54) Title: METHOD FOR CHARACTERISING PARTICLES IN SUSPENSION FROM FREQUENCY DOMAIN PHOTON MI-
GRATION MEASUREMENTS



(57) Abstract: Methods are provided for measuring isotropic scattering coefficients of suspensions using multiply scattered radiation that is modulated in amplitude at selected modulation frequencies. The radiation may be light. Quantities describing diffusion of the multiply scattered radiation are preferably measured at a plurality of distances between source and receiver and a plurality of frequencies. Linear regression techniques are provided for maximizing accuracy of the scattering data at a selected wavelength of a radiation. Methods are provided for inverting an integral equation so as to determine a calculated value of scattering coefficient. Parameters are varied to minimize the difference between the calculated and measured scattering coefficients and thereby to determine volume fraction, particle size distribution and interparticle force between the particles in a suspension. By incorporating a first principles model to account for interparticle force, the measurements can be used to determine a parameter governing interparticle forces in a suspension. The suspension may be in a liquid or a gas.



WO 02/082055 A3

**Declarations under Rule 4.17:**

— as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

— as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 02/10433

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 G01N21/47 G06F17/14 G01N21/49 G01N15/14 G01N15/02
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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G01N G06F C12M C12Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 818 583 A (SEVICK-MURACA EVA ET AL) 6 October 1998 (1998-10-06) cited in the application column 1, line 15 -column 1, line 49 column 2, line 55 -column 2, line 67 column 3, line 57 -column 4, line 60 column 5, line 53 -column 7, line 50 column 8, line 48 -column 8, line 62 column 9, line 4 -column 11, line 32 column 12, line 33 -column 14, line 14 column 15, line 32 -column 15, line 45 column 16, line 3 -column 18, line 64 figures 1-12 --- -/--	1-3,5, 7-12, 29-33

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *Z* document member of the same patent family

Date of the actual completion of the international search

3 June 2003

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 02/10433

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 00 22414 A (SEVICK MURACA EVA M ;MAYER RALF H (US); PURDUE RESEARCH FOUNDATION) 20 April 2000 (2000-04-20)	1-3,6,8, 11,12
Y	page 3, line 5 -page 4, line 17 page 6, line 9 -page 9, line 2 page 9, line 12 -page 15, line 27 page 21, line 4 -page 21, line 10 page 22, line 9 -page 23, line 26 page 24, line 1 -page 24, line 19 figures 1-10	30
X	GB 2 311 366 A (UNIV LONDON) 24 September 1997 (1997-09-24) page 1, paragraph 1 page 1, paragraph 3 -page 2, paragraph 2 page 3, paragraph 4 -page 5, paragraph 2 page 7, line 1 -page 11, line 2 page 14, line 1 -page 15, paragraph 4 page 16, paragraphs 1,2 page 19, paragraph 2 -page 20, paragraph 1 page 20, paragraph 6 -page 21, paragraph 5 figures 1-13	1-3,6-8, 12
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X	SUN Z ET AL: "APPROACH FOR PARTICLE SIZING IN DENSE POLYDISPERSE COLLOIDAL SUSPENSION USING MULTIPLE SCATTERED LIGHT" LANGMUIR, ACS, WASHINGTON, DC, US, vol. 17, no. 2, 2001, pages 6142-6147, XP001126299 ISSN: 0743-7463 cited in the application	1-5, 7-12, 26-29, 31-35
Y	the whole document	20, 23-25,30
X	RICHTER S M ET AL: "PARTICLE SIZING USING FREQUENCY DOMAIN PHOTON MIGRATION" PARTICLE AND PARTICLE SYSTEMS CHARACTERIZATION, VCH, WEINHEIM, DE, vol. 15, no. 9, February 1998 (1998-02), pages 9-15, XP008010433 ISSN: 0934-0866 cited in the application	26-29, 32,34,35
Y	the whole document	13,15-20
	-/--	

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 02/10433

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>ISAYEV K B ET AL: "Study of thermophysical properties of a metal-hydrogen system" INTERNATIONAL JOURNAL OF HYDROGEN ENERGY, ELSEVIER SCIENCE PUBLISHERS B.V., BARKING, GB, vol. 21, no. 11-12, 12 November 1996 (1996-11-12), pages 1129-1132, XP004070799 ISSN: 0360-3199 page 1130, column 1, line 46 -page 1130, column 2, paragraph 2</p>	13,20
Y	<p>EP 0 959 341 A (DEUTSCH ZENTR LUFT & RAUMFAHRT) 24 November 1999 (1999-11-24)</p> <p>page 2, line 3 -page 2, line 7 page 2, line 25 -page 2, line 30 page 2, line 49 -page 3, line 58 page 4, line 4 -page 5, line 47 page 6, line 20 -page 12, line 13 figures 2,3</p>	13, 15-20, 23-25
A	<p>PANDA R ET AL: "Generalized B-spline signal processing" SIGNAL PROCESSING. EUROPEAN JOURNAL DEVOTED TO THE METHODS AND APPLICATIONS OF SIGNAL PROCESSING, ELSEVIER SCIENCE PUBLISHERS B.V. AMSTERDAM, NL, vol. 55, no. 1, 1 November 1996 (1996-11-01), pages 1-14, XP004016005 ISSN: 0165-1684 the whole document</p>	13,20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 02/10433

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest.
- No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-12,29-33

A method for measuring an isotropic scattering coefficient for radiation being multiply scattered in a suspension of particles, and an apparatus for measuring volume fraction, particle size distribution or interaction of particles in a suspension

2. Claims: 13-25

A method for determining at least one of parameters describing a non-interacting suspension

3. Claims: 26-28

A system for executing a computer program

4. Claims: 34-36

A method for measuring a parameter governing interparticle forces in a suspension

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 02/10433

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
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