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(54) Title: WATER-SOLUBLE HYDROGEL-BASED DENTAL COMPOSITION AND METHODS OF MAKING AND USING SAME

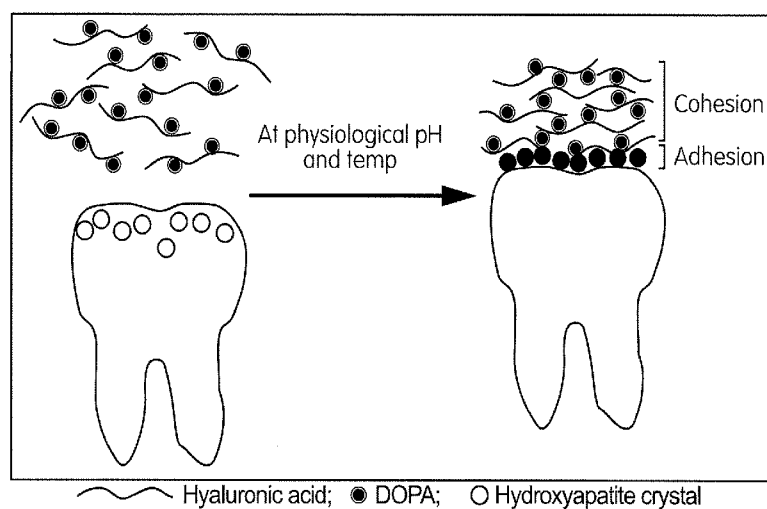


FIG. 23

(57) Abstract: Described herein are dental compositions, more particularly water soluble dental varnish composition useful for effective fluoridation, *in situ* biomimetic remineralization and improved adhesion to enamel. The dental composition includes a hydrogel-forming polymer having cohesive properties to itself and adhesive properties to a dental enamel. The hydrogel forming polymer includes a water-soluble polymer and an adhesion promotor chemically and/or physically conjugated to the water-soluble polymer. The embodiments also provide methods of forming a hydrogel forming polymer and use of hydrogel forming polymer to prepare such dental composition.



GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/042924

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 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 No. III Observations where unity of invention is lacking (Continuation of item 3 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 fees, this Authority did not invite payment of additional fees.
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 and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER INV. A61K6/00 A61L27/52 A61L27/38 ADD.		
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) A61L A61K		
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 practicable, search terms used) EPO-Internal, CHEM ABS Data, EMBASE, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2016/190400 A1 (JAPAN SCIENCE & TECH AGENCY [JP]) 1 December 2016 (2016-12-01)	1-15
Y	the whole document page 8, paragraph 45 - paragraph 46 & EP 3 305 866 A1 (JAPAN SCIENCE & TECH AGENCY [JP]) 11 April 2018 (2018-04-11) paragraph [0044] - paragraph [0046] -----	16-33, 40-45
X	MARIE KROGSGAARD ET AL: "Self-Healing Mussel-Inspired Multi-pH-Responsive Hydrogels", BIOMACROMOLECULES, vol. 14, no. 2, 11 February 2013 (2013-02-11), pages 297-301, XP055062292, ISSN: 1525-7797, DOI: 10.1021/bm301844u the whole document ----- -/-	1-33, 40-45
☒ Further documents are listed in the continuation of Box C. ☒ See patent family 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 application or patent 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 "&" document member of the same patent family		
Date of the actual completion of the international search 15 January 2019		Date of mailing of the international search report 23/01/2019
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Siatou, Evangelia

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2018/042924

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	----- FAN CHANGJIANG ET AL: "A mussel-inspired double-crosslinked tissue adhesive intended for internal medical use", ACTA BIOMATERIALIA, ELSEVIER, AMSTERDAM, NL, vol. 33, 2 February 2016 (2016-02-02), pages 51-63, XP029441408, ISSN: 1742-7061, DOI: 10.1016/J.ACTBIO.2016.02.003 abstract page 52, paragraph 2.1. page 53, paragraph 2.3. page 56; figure 2	1-15
Y	----- US 2017/151158 A1 (MYERS CARL [US] ET AL) 1 June 2017 (2017-06-01) claims 1-18	16-19
X	----- ZHANG HONG ET AL: "Mussel-inspired hyperbranched poly(amino ester) polymer as strong wet tissue adhesive", BIOMATERIALS, vol. 35, no. 2, 2014, pages 711-719, XP028760828, ISSN: 0142-9612, DOI: 10.1016/J.BIOMATERIALS.2013.10.017 abstract	1,2,4,5, 8
X	----- HYUKJIN LEE ET AL: "Catechol-Grafted Poly(ethylene glycol) for PEGylation on Versatile Substrates", LANGMUIR, vol. 26, no. 6, 16 March 2010 (2010-03-16) , pages 3790-3793, XP055030942, ISSN: 0743-7463, DOI: 10.1021/la904909h abstract	1,2,4,5, 8,9
X	----- LEE B P ET AL: "Synthesis of DOPA-modified Polyethylene glycol hydrogels", BIOMACROMOLECULES, AMERICAN CHEMICAL SOCIETY, US, vol. 3, no. 5, 1 September 2002 (2002-09-01), pages 1038-1047, XP002698767, ISSN: 1525-7797, DOI: 10.1021/BM025546N [retrieved on 2002-04-07] abstract	1,2,4,5, 8,9
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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2018/042924

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	SEONKI HONG ET AL: "Hyaluronic Acid Catechol: A Biopolymer Exhibiting a pH-Dependent Adhesive or Cohesive Property for Human Neural Stem Cell Engineering", ADVANCED FUNCTIONAL MATERIALS, WILEY - V C H VERLAG GMBH & CO. KGAA, DE, vol. 23, no. 14, 12 April 2013 (2013-04-12), pages 1774-1780, XP001582423, ISSN: 1616-301X, DOI: 10.1002/ADFM.201202365 [retrieved on 2012-11-07] abstract -----	1,2,4,5, 8,9
X	WO 2013/095366 A1 (COLGATE PALMOLIVE CO [US]; MORGAN ANDRE [US]; JOZIAK MARILLOU [US]; PRE) 27 June 2013 (2013-06-27)	34-39
Y	claims 1-8, 12-18 page 6, paragraph 36 - paragraph 37 page 10, paragraph 52 page 11; example VI; table 1 -----	20-33, 40-45
E	WO 2018/183647 A1 (DENTSPLY SIRONA INC [US]) 4 October 2018 (2018-10-04) the whole document -----	20-22, 40-45

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2018/042924

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FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-19

Composition comprising a hydrogel-forming polymer having cohesive properties to itself and adhesive properties to a wet surface and water.

2. claims: 20-33, 40-45

Water soluble dental varnish composition comprising a hydrogel-forming polymer, wherein the hydrogel-forming polymer is water soluble polymer with dopamine chemically and/or physically attached to, and a fluoride agent. A method for applying the water-soluble, fluoride-containing dental composition to a surface of a tooth.

3. claims: 34-39

Method for preparing a water soluble dental composition comprising the steps of
a) dissolving a hydrogel-forming polymer to water,
b) adding an antioxidant and a metal ion source and a branched cationic polymer to water to form a branched cationic polymer solution,
c) adding the branched cationic polymer solution to the hydrogel-forming polymer,
d) dissolving an antioxidant in water to form a second solution, and adding this second solution to the solution of step c),
e) adding an antioxidant to the solution of step d) to form the water soluble dental composition.
