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(71) **Applicant**: **DOW GLOBAL TECHNOLOGIES LLC** [US/US]; 2040 Dow Center, Midland, MI 48674 (US).

(72) **Inventors**: **READ, Michael, D.**; 3655 North Perrine Road, Midland, MI 48642 (US). **BAWISKAR, Santosh, S.**; 5307 Belle Manor Lane, Sugar Land, TX 77479 (US).

(74) **Agent**: **TERRY, Jane**; The Dow Chemical Company, P.O. Box 1967, Midland, Michigan 48641-1967 (US).

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— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(88) **Date of publication of the international search report**:
8 October 2015

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(54) **Title**: METHOD TO PRODUCE FUNCTIONALIZED, LOW VISCOSITY ETHYLENE-BASED POLYMERS

(57) **Abstract**: The invention provides a process to form a "functionalized ethylene-based polymer" from an ethylene-based polymer and at least one polar compound, said process comprising thermally treating a composition comprising the ethylene-based polymer, the at least one polar compound, and at least one peroxide, in at least one extruder comprising at least one barrel, to form a polymer melt; and wherein the at least one peroxide has a half life, at the maximum barrel temperature of the at least one extruder, of less than of the minimum residence time of the polymer melt in the at least one extruder. The invention further provides a composition comprising at least the following: a) an ethylene-based polymer comprising a melt viscosity, at 350°F (177°C), less than 50.000 cP, and b) at least one peroxide comprising a half-life from 0.10 to 2.00 minutes, at a temperature from 160°C to 190°C.

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A. CLASSIFICATION OF SUBJECT MATTER
INV. C08F8/00 C08F10/02 C08L23/04 C08K5/00 C08K5/14
C08L23/26
ADD. C08F255/02 C08F222/06 C08L23/08
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)
C08F C08K C08L

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, WPI Data, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 134 927 A (TOMOSHIGE TORU ET AL) 16 January 1979 (1979-01-16) comparative example 5; claims; examples 1-6; table 1 comparative example 18; claim 4; example 13	1-7,9,10
X	US 2011/003942 A1 (TSUKUI HITOSHI [JP] ET AL) 6 January 2011 (2011-01-06) paragraph [0082]; claims; example 1 paragraph [0014]	1-7,9,10
X	US 2005/059783 A1 (FURRER WILLY [CH] ET AL) 17 March 2005 (2005-03-17) claims 1-3,6-11; examples 1,2 paragraphs [0043], [0044], [0054]	1-4,6-9

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[X] Further documents are listed in the continuation of Box C.

[X] 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)

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"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	Date of mailing of the international search report
16 June 2015	24/08/2015

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Hollender, C

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 7 897 689 B2 (HARRIS WILLIAM J [US] ET AL) 1 March 2011 (2011-03-01) cited in the application claims 1-5,11-15 column 69, lines 14-41 column 78, line 1 - column 80, line 19 -----	1-6,9,10

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2014/070647

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4134927 A	16-01-1979	CA 1073587 A1	11-03-1980
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INTERNATIONAL SEARCH REPORT

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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.:

1-10

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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-10

A process (as defined in claims 1 to 10) to form a "functionalized ethylene-based polymer" from an ethylene-based polymer and at least one polar compound, said process comprising thermally treating a composition comprising the ethylene-based polymer, the at least one polar compound, and at least one peroxide, in at least one extruder comprising at least one barrel, to form a polymer melt; and wherein the at least one peroxide has a half life, at the maximum barrel temperature of the at least one extruder, of less than 1/4 of the minimum residence time of the polymer melt in the at least one extruder.

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2. claims: 11-15

A composition (as defined in claims 11 to 14) comprising at least the following:
a) an ethylene-based polymer comprising a melt viscosity, at 350°F (177°C), less than 50.000 cP, and
b) at least one peroxide comprising a half-life from 0.10 to 2.00 minutes, at a temperature from 160°C to 190°C.
An article (as defined in claim 15) comprising at least one component formed from the composition of any one of claims 11-14.
