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(54) Title: BIDIRECTIONAL SHAPE-MEMORY POLYMER, METHOD OF ITS PRODUCTION AND ITS USE

(57) Abstract: The present invention relates to an article consisting of or comprising a bidirectional shape-memory polymer (bSMP), the bSMP comprising: first phase-segregated domains (AD) having a first transition temperature (T_{LAD}) corresponding to a crystallization transition or glass transition of the first domains (AD), second phase-segregated domains (SD) having a second transition temperature (T_{LSD}) corresponding to a crystallization transition or glass transition of the second domains (SD), the second transition temperature (T_{LSD}) being higher than the first transition temperature (T_{LAD}), and covalent or physical bonds cross-linking the polymer chains of the bSMP, and in this way interconnecting the first and second domains (AD, SD), wherein the second phase-segregated domains (SD) form a skeleton which is at least partially embedded in the first phase-segregated domains (AD), and wherein polymer chain segments of the bSMP forming the first domains (AD) are substantially orientated in a common direction, such that the bSMP is able to undergo a reversible shape-shift between a first shape (A) at a first temperature (T_{high}) and a second shape (B) at a second temperature (T_{low}) upon variation of temperature between the first and second temperature (T_{high} , T_{low}) driven by the crystallization and melting or vitrification and melting of the first phase-separated domains (AD) and without application of an external stress, with $T_{low} < T_{LAD} < T_{high} < T_{LSD}$.

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
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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)
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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, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 99/42528 A2 (MNEMOSCIENCE GMBH [DE]; LANGER ROBERT S [US]) 26 August 1999 (1999-08-26) claims 31,32 page 1, paragraph 2 page 2, paragraph 1 page 5, line 3 - line 11 page 8, paragraph 3	1-15
A	----- WO 2009/095434 A1 (GEESTHACHT GKSS FORSCHUNG [DE]; KRATZ KARL [DE]; LENDLEIN ANDREAS [DE]) 6 August 2009 (2009-08-06) claims	1,11
A	----- WO 2007/060019 A2 (MINEMOSCIENCE GMBH [DE]; LENDLEIN ANDREAS [DE]; HASSON TAREQ ALI ABDUL) 31 May 2007 (2007-05-31) claims 1,2,4,9,13 -----	1,11

Further documents are listed in the continuation of Box C.

See patent family annex.

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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 Niaounakis, Michael
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9942528	A2	26-08-1999	AT 327287 T 15-06-2006
			AU 758800 B2 27-03-2003
			AU 3308499 A 06-09-1999
			BR 9908339 A 02-10-2001
			CA 2316945 A1 26-08-1999
			DE 69931474 T2 10-05-2007
			DK 1062278 T3 25-09-2006
			EP 1062278 A2 27-12-2000
			ES 2265186 T3 01-02-2007
			HU 0102138 A2 28-09-2001
			IL 137878 A 10-04-2006
			JP 3732404 B2 05-01-2006
			JP 2002504585 A 12-02-2002
			KR 100415373 B1 16-01-2004
			PL 342996 A1 16-07-2001
			TR 200002451 T2 21-03-2001
			US 6388043 B1 14-05-2002
			US 2003055198 A1 20-03-2003
			WO 9942528 A2 26-08-1999

WO 2009095434	A1	06-08-2009	CN 101983215 A 02-03-2011
			EP 2238190 A1 13-10-2010
			HK 1154035 A1 15-11-2013
			JP 5383706 B2 08-01-2014
			JP 2011513506 A 28-04-2011
			KR 20110037931 A 13-04-2011
			WO 2009095434 A1 06-08-2009

WO 2007060019	A2	31-05-2007	EP 1790694 A1 30-05-2007
			EP 1954762 A2 13-08-2008
			US 2009163664 A1 25-06-2009
			WO 2007060019 A2 31-05-2007
