Heusler Alloy Replacement for Iridium

D7.5 Plan for use & dissemination of foreground

version: 1.1

date: 17-Mar-17

WP no and title	WP7: Dissemination and exploitation
WP leader	MACK
Responsible Author(s)	Nigel Mackintosh (MACK)
Due delivery month	m43
Actual delivery month	m43
Dissemination	Public

Project Funded by the European Commission under the 7th Framework Programme (FP7-NMP-2013-EU-Japan) – Grant Agreement No: NMP3-SL-2013-604398 – Acronym: "HARFIR"

Filename: HARFIR - D7.5 Plan for use & dissemination of foreground - v1.1.docx
Last saved: 17-Mar-17 8:16PM

DOCUMENT HISTORY

Version	*Issue Date*	*Content/changes*
0.3	17-Feb-17	Draft release to partners for inputs
0.4	10-Mar-17	Added UoY & BME exploitation ideas
1.0	14-Mar-17	Added approvals
1.1	17-Mar-17	Corrected some publication dates

APPROVALS

Date	*Reviewer*
13-Mar-17	A Hirohata
13-Mar-17	K O'Grady

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1 EXECUTIVE SUMMARY

The **Plan for Use and Dissemination of the Foreground (PUDF)** presented here details the Consortium's dissemination and exploitation (D&E) activities which *have already been carried out* during the project implementation and those *still expected after project completion*. Its content will be made available in the public domain, thus demonstrating the added-value and positive impact of the project on the European Union.

The **two key areas** addressed by this deliverable are the dissemination and the exploitation actions which are separately reported in **Section A** and **Section B**.

Section A describes and details all of the project's dissemination activities and Dissemination activities have been performed during the entire 43 months of the project (September 2013 – March 2017).

Section B details the project's *very limited* exploitation plan to be carried out by Consortium partners. It defines the exploitable foreground and our plans for its exploitation.

2 SECTION A: DISSEMINATION

2.1 List of scientific publications

Nº	D.O.I.	Title	Author(s)	Title of the periodical	Number	Publisher	Place of publi-cation	Date of publi-cation	pages	OA
1	10.1103/PhysRevLett.111.217202	Exchange Bias Driven by Dzyaloshinskii-Moriya Interactions	R. Yanes, J. Jackson, L. Udvardi, L. Szunyogh, U. Nowak	Physical Review Letters	Vol. 111 / Issue 21	American Physical Society	United States	20-11-13	217202	No
2	10.1016/j.jallcom.2014.02.035	Multiple phases in sputtered Cr_2CoGa films	Manuel P. Geisler, Markus Meinert, Jan Schmalhorst, Günter Reiss, Elke Arenholz	Journal of Alloys and Compounds	Vol. 598	Elsevier BV	Netherlands	15-02-14	213-216	No
3	10.1103/PhysRevB.91.094432	Antiferromagnetism in Ru_2MnZ (Z=Si,Ge,Sb,Sn) full Heusler alloys: effects of magnetic frustration and chemical disorder	Sergii Khmelevskyi, Eszter Simon, László Szunyogh	Physical Review B - Condensed Matter and Materials Physics	Vol. 91 / Issue 9	American Physical Society	United States	30-03-15	94432	No
4	10.1103/PhysRevB.92.054438	Magnetism of ordered and disordered Ni_2MnAl full Heusler compounds	E. Simon, J. Gy. Vida, S. Khmelevskyi, L. Szunyogh	Physical Review B - Condensed Matter and Materials Physics	Vol. 92 / Issue 5	American Physical Society	United States	28-08-15	054438	Yes
5	10.1109/TMAG.2015.2457393	Roadmap for Emerging Materials for Spintronic Device Applications	Atsufumi Hirohata, Hiroaki Sukegawa, Hideto Yanagihara, Igor Zutic, Takeshi Seki, Shigemi Mizukami, Raja Swaminathan	IEEE Transactions on Magnetics	Vol. 51 / Issue 10	Institute of Electrical and Electronics Engineers Inc.	United States	16-07-15	1-11	Yes
6	10.1063/1.4939092	Exchange bias in epitaxial and polycrystalline thin film Ru_2MnGe/Fe bilayers	Jan Balluff, Markus Meinert, Jan-Michael Schmalhorst, Günter Reiss, Elke Arenholz	Journal of Applied Physics	Vol. 118 / Issue 24	American Institute of Physics Inc.	United States	31-12-15	243907	No
7	10.1088/0022-3727/49/23/235001	Exchange bias effects in Heusler alloy Ni_2MnAl/Fe bilayers	Tomoki Tsuchiya, Takahide Kubota, Tomoko Sugiyama, Teodor Huminiuc, Atsufumi Hirohata, Koki Takanashi	Journal of Physics D - Applied Physics	Vol. 49 / Issue 23	Institute of Physics Publishing	United Kingdom	12-05-16	235001	No

8	10.1016/j.jallcom.2016.09.017	Microscopic origin of ferro-antiferromagnetic transition upon non-magnetic substitution in $Ru_2(Mn_{1-x}V_x)Ge$ full Heusler alloys	Sergii Khmelevskyi, Eszter Simon, László Szunyogh, Peter Mohn	Journal of Alloys and Compounds	Vol. 692	Elsevier BV	Netherlands	4-09-16	178-182	No
9	n/a	Exchange bias induced at a $Co_2FeAl_{0.5}Si_{0.5}$/Cr interface	Chris N. T. Yu, Andrew J. Vick, Nobuhito Inami, Kanta Ono, William Frost, Atsufumi Hirohata	Journal of Physics D - Applied Physics	in press	Institute of Physics Publishing	United Kingdom	1-03-17	Un-known	Yes
10	not yet known	Interfacial exchange interactions and magnetism of Ni_2MnAl/Fe bilayers	R. Yanes, E. Simon, S. Keller, S. Khmelevsky, L. Szunyogh and U. Nowak	Physical Review B	being submitted	American Physical Society	United States	Un-known	Un-known	No

2.2 List of dissemination measures

N°	*Type of activities[1]*	*Main leader*	*Title*	*Date*	*Place*	*Type of audience[2]*	*Size of audience*	*Countries addressed*
1	Websites/Apps	MACK	HARFIR public website	10-11-13	www.harfir.eu	SC - Ind - CS - PM - Medias	8,000	all
2	Websites/Apps	UoY	HARFIR Kick-off Meeting Report	11-11-13	HARFIR website	SC - Ind - CS - PM - Medias	8,000	all
3	Oral	UoY	European Raw Materials information and brokerage event	13-11-13	London	SC - Ind	50	UK
4	Press releases	UoY	Scientists developing new cost-effective materials for magnetic storage devices	14-11-13	UoY website and UK science and technology correspondents	Medias	1000	UK
5	Oral	UNIBI	DPG spring meeting	4-04-14	Dresden, Germany	SC - Ind	100	all
6	Oral	UoY	Magnetism 2014	7-04-14	Manchester, UK	SC - Ind	100	all
7	Posters	BME	IEEE International Magnetics Conference	4-05-14	Dresden	SC - Ind	400	all
8	Workshop	UoY	HARFIR Open Workshop #1	5-05-14	International Congress Centre Dresden	SC - Ind	26	all
9	Posters	UKON	Intermag	6-05-14	Dresden, Germany	SC - Ind	200	all
10	Websites/Apps	MACK	D7.2 Workshop #1 Report	19-06-14	HARFIR website	SC - Ind	8,000	all
11	Press	UoY	Heusler alloys in magnetic recording	26-06-14	Magnetics Technology International	SC - Ind	3000	all
12	Workshop	UoY	HARFIR Open Workshop #2	12-09-14	Sendai, Japan	SC - Ind	36	all

13	Oral	BME	WE-Heraeus Seminar	9-02-15	Bad Honnef, Germany	SC - Ind	50	DE
14	Oral	UoY	Heusler Alloy Replacement for Iridium	10-02-15	Brussels	SC - Ind - PM	30	EU
15	Oral	UoY	3rd Strategic Workshop Event of Innovation Network for Substitution of Critical Raw Materials	11-02-15	Brussels, Belgium	SC - Ind - PM	20	EU
16	Posters	UNIBI	79th Annual Meeting of the DPG and DPG Spring Meeting	15-03-15	Berlin	SC - Ind	300	all
17	Oral	UNIBI	DPG spring meeting	18-03-15	Berlin, Germany	SC - Ind	100	all
18	Posters	BME	SPICE-Workshop on Computational Quantum Magnetism	22-05-15	Mainz	SC	50	DE, EU
19	Oral	UoY	8th International Conference on Materials for Advanced Technologies of the Materials Research Society of Singapore & 16th International Conference in Asia	2-06-15	Singapore	SC - Ind	50	all
20	Oral	UoY	JSPS York-Tohoku-Kaiserslautern Research Symposium on New Concept Spintronics Devices	11-06-15	York	SC - Ind	75	all
21	Workshop	UoY	HARFIR Open Workshop #3	13-06-15	York, UK	SC - Ind	109	EU, Japan, USA, Hong Kong
22	Oral	UoY	4th Strategic Workshop Event of Innovation Network for Substitution of Critical Raw Materials	17-06-15	Brussels, Belgium	SC - Ind - PM	20	EU
23	Oral	UoY	20th International Conference on Magnetism	5-07-15	Barcelona, Spain	SC - Ind	100	all
24	Websites/Apps	UoY	D7.4 Workshop #3 report	20-07-15	HARFIR website	SC - Ind	8,000	all
25	Oral	UNIBI	The 1st ImPACT International Symposium on Spintronic Memory, Circuit and Storage	21-07-15	Tokyo, Japan	SC - Ind	75	all
26	Oral	UoY	The Magnetics Society of Japan 203rd Workshop	24-07-15	Tokyo, Japan	SC - Ind	75	Japan
27	Oral	UNIBI	C-Spin meeting on Heusler Alloys for Spintronic Devices	30-07-15	Minneapolis, MN, USA	SC - Ind	100	all
28	Press	UoY	Shift from electronics to spintronics opens up possibilities of faster data	2-09-15	"The Conversation" Journal	SC - Ind - Medias	1000	all
29	Oral	UoY	The 39th Annual Conference on Magnetics in Japan	8-09-15	Nagoya, Japan	SC - Ind	75	Japan
30	Oral	UoY	2015 Fall Annual (157th) Meeting of the Japan Institute of Metals and Materials	16-09-15	Fukuoka, Japan	SC - Ind	50	Japan
31	Oral	BME	Workshop on Controlling Magnetic Nanostructures	23-09-15	Konstanz, DE	SC	40	EU

32	Oral	UoY	Heusler Alloys for Spintronic Devices	25-10-15	IUMRS-ICAM2015 in Seoul, Korea	SC	100	EU, Japan, USA, Hong Kong, Korea
33	Oral	UoY	2nd Korea-EU Bilateral Workshop on Advanced Functional Materials	25-10-15	Jeju, Korea	SC - Ind	50	Korea, EU
34	Oral	UoY	Heusler Alloys for Spintronic Devices	27-10-15	IUMRS-ICAM2015 in Seoul, Korea	SC	100	EU, Japan, USA, Hong Kong, Korea
35	Oral	UoY	14th International Union of Materials Research Societies (IUMRS) - International Conference on Advanced Materials (ICAM)	27-10-15	Jeju, Korea	SC - Ind	40	Korea, EU
36	Workshop	UoY	HARFIR Open Workshop #4	6-11-15	KEK, Tsukuba, Japan	SC	19	USA,EU,Japan
37	Oral	UoY	Tohoku-York-Kaiserslautern JSPS Core-to-Core Workshop on ?New-Concept Spintronics Devices"	13-11-15	Sendai, Japan	SC - Ind	70	Japan, EU
38	Websites/Apps	MACK	Report on Open Workshop #4	3-12-15	HARFIR website	SC - Ind	8,000	all
39	Oral	UoY	13th Joint MMM-Intermag Conference	11-01-16	San Diego, USA	SC - Ind	100	all
40	Oral	BME	80th Annual Conference of DPG and Spring Meeting of the Condensed Matter Section	1-03-16	Regensburg, Germany	SC - Ind	50	all
41	Oral	UNIBI	DPG spring meeting	10-03-16	Regensburg, Germany	SC - Ind	100	EU
42	Oral	UoY	EPSRC-JSPS Core-to-Core Workshop on HAs	16-03-16	York, UK	SC - Ind	70	EU, Japan
43	Oral	UoY	Magnetism 2016	4-04-16	Sheffield, UK	SC - Ind	100	all
44	Oral	UoY	European Materials Res Soc 2016 Spring Meeting	3-05-16	Lille, France	SC - Ind	80	EU
45	Workshop	UKON	HARFIR Open Workshop #5	30-05-16	University of Konstanz, Germany	SC - Ind	12	USA,EU,Japan
46	Websites/Apps	UKON	Report on the 5th Japan-EU Open Workshop	29-07-16	HARFIR website	SC - Ind	12	all
47	Posters	BME	JEMS 2016	21-08-16	Glasgow	SC - Ind	60	all
48	Oral	UoY	COST Action CRM-EXTREME meeting	7-10-16	Burgos	SC - Ind	50	EU
49	Oral	UoY	The Magnetics Society of Japan 209th Workshop	21-10-16	Tokyo, Japan	SC - Ind	50	all
50	Oral	UKON	61st Annual Conference on Magn & Mag Materials	31-10-16	New Orleans, USA	SC - Ind	120	all
51	Oral	UoY	Critical Raw Materials and Substitution meeting	2-12-16	Brussels	SC - Ind - PM	20	EU

[1]*Oral = Oral presentation to a scientific event; Workshop = Org of Workshops; Press = Articles published in the popular press*

[2]*SC = Scientific community (higher education, Research); Ind = "Industry; PM = Policy Makers; CS = Civil society*

3 SECTION B: EXPLOITATION

3.1 Intellectual Property Rights applied for

None.

3.2 Exploitable foreground results

3.2.1.....Overview

Type of Exploitable Foreground	*Description of exploitable foreground*	*Confi-dential (YES/NO)*	*Foreseen embargo date*	*Exploitable product(s) or measure(s)*	*Sector(s) of application*	*Timetable for commercial or any other use*	*Patents or other IPR exploitation (licences)*	*Owner & Other Beneficiary(s) involved*
Commercial exploitation of R&D results	Néel temperature determination by resistivity measurements	No		Néel temperature determination for a thin film antiferromagnet	Industrial inspection	2 years	none	Possible collaboration with an equipment manufacturer
Non-commercial exploitation of R&D results	Spin-model parametrization of hybrid magnets	No		Relativistic spin-model parameters for complex magnetic materials (bulk alloys, surfaces, interfaces, multilayers)	Basic research and technology	2 years		BME, UOY

3.2.2.....Néel temperature determination by resistivity measurements

The determination of the Néel temperature of an antiferromagnet via resistivity measurements has been known for some time but has generally been demonstrated on bulk materials. In order to achieve the same measurement in a thin film, we have developed a resistivity apparatus whose design is the same as many other systems around the world but we have developed control software and measurement routines that give our system a resolution significantly better than any other system in the world of which we are aware.

Therefore, in principle, such a piece of apparatus could be exploited commercially. However the number of workers around the world who would be interested in such a system means that the benefits of exploitation are likely to be minimal – if any would exist at all. It is also clear that it would not be possible to take IP protection on a measurement procedure with any prospect of enforcement.

Hence, if any exploitation of this technique were feasible, it would be best undertaken via a collaboration with an existing instrument maker through which the measurement routines and perhaps even the LabView software was shared with them for a modest financial contribution.

Given that the development of the instrument was undertaken by a PhD student, it will also be a requirement that the development of the measurement routines would be included in his thesis. Whilst this would constitute publication of the technique it would not significantly affect the value of what has been achieved, which would lie in the software routines themselves.

3.2.3.....Spin-model parametrization of hybrid magnets

The purpose of this work is the calculation of spin-model parameters (tensorial exchange interactions and anisotropy parameters) for hybrid magnetic materials on a large scale of composition and geometry, and using them in atomistic spin-dynamics simulations

Exploitation could be achieved by producing an interface between the SKKR code package of BME and atomistic spin-dynamics codes, in particular the VAMPIRE code at the University of York (see http://www-users.york.ac.uk/~rfle500/research/vampire/).

Further research required might involve: improved implementation of the LDA+U method into the SKKR package; including higher-order spin-interactions; extension to finite nanoparticles.

In terms of the potential and expected impact, the SKKR-VAMPIRE package is expected to be widely applicable for purposes of technological developments – e.g., for magnetic tunnelling junctions with improved properties.

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