

Vurdering av søknad sendt til Norges forskningsråd

Søknad

Prosjektnummer	325279
Prosjekttittel	Solid state cooling with elastocaloric materials (Cool'em)
Prosjektleder	Løvvik, Ole Martin
Prosjektansvarlig	SINTEF AS
Søknadstype/variant	Forskerprosjekt / Fornyelse
Tema	Nanoteknologi, avanserte materialer, synkrotron og nøytronforskning
Program/Aktivitet	Forskerprosjekt 2021
Saksbehandler	Karin Totland

Karakteroversikt

Kriterier	Karakter
Relevans for valgt tema	7

Kriterier

Relevans for valgt tema

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I hvilken grad prosjektet tilfredsstiller prioriteringene i valgt tema i utlysningen.

Nanoteknologi, avanserte materialer, synkrotron og nøytronforskning:

Søknaden bidrar i stor grad til å bygge kunnskap og nye metoder innenfor nanoteknologi, mikroteknologi og/eller avanserte materialer.

Søknaden er innenfor temaet Medisin og helse, Miljøvennlig energi og lavutslipp, Bærekraft, miljø og klima som har en viss prioritering i utlysningen.

Søknaden inkluderer svært relevante refleksjoner og tiltak som bidrar til at forskningen som planlegges gjennomført, er i tråd med forventinger om ansvarlig forskning (RRI).

Valgt karakter: 7 - Fremragende

Søknaden svarer særdeles godt på kriteriet. Den har ingen vesentlige mangler.

Sjekkpunkter

Kommentar til sjekkpunkter

Assessment of grant application submitted to the Research Council of Norway

Grant application

Project number	325279
Project title	Solid state cooling with elastocaloric materials (Cool'em)
Project manager	Løvvik, Ole Martin
Project owner	SINTEF AS
Application type	Researcher Project / Researcher Project for Scientific Renewal
Topic	Nanotechnology, advanced materials, synchrotron and neutron research
Programme/Activity	Forskerprosjekt 2021
Case officer	Karin Totland

Confirmation

By completing and submitting this form, I / we confirm the following (applies for the individual referee or the referee panel):

- I/We have no conflicts of interest that would prevent me/us from conducting this assessment. See Regulations on Impartiality and Confidence in the Research Council of Norway.	Yes
- I/We have read and understood both the criteria I/we have been asked to use for assessing the application and the description of the scale of marks. The scale of marks is to be applied as an absolute scale, i.e. marks are to be determined for each grant application independently and not relative to other applications that the panel/referee is assessing.	Yes
- I/We understand and accept the guidelines for assessing applications for the Research Council of Norway. See Guidelines for referees/panels who assess applications for the Research Council of Norway.	Yes
- I am/We are qualified to conduct this assessment.	Yes

Summary of marks

Criterion	Mark
Excellence	7
Impact	7
Implementation	7
Overall assessment of the referee/panel	7

Criteria

Excellence

The extent to which the proposed work is ambitious, novel, and goes beyond the state-of-the-art

- Scientific creativity and originality.
- Novelty and boldness of hypotheses or research questions.
- Potential for development of new knowledge beyond the current state-of-the-art, including significant theoretical, methodological, experimental or empirical advancement.

The quality of the proposed R&D activities

- Quality of the research questions, hypotheses and project objectives, and the extent to which they are clearly and adequately specified.
 - Credibility and appropriateness of the theoretical approach, research design and use of scientific methods.
- Appropriate consideration of interdisciplinary approaches.
- The extent to which appropriate consideration has been given to ethical issues, safety issues, gender dimension in research content, and use of stakeholder/user knowledge if appropriate.

The proposed research is ambitious in its aim to develop a solid state cooling device for the temperature range above 20 Kelvin, which is superior to state-of-the-art fluid-based cooling devices and consists of non-critical non-toxic elements. The proposed project is about electro-caloric cooling and aims at identifying and synthesizing novel alloys that display a morphotropic phase transition between martensitic and austenite phases, but in which this transition occurs without atomic diffusion or interface stress (supercompatibility), which was recently shown to enhance the endurance by several orders of magnitude. It is an original and timely approach to screen all binary and ternary alloys and intermetallics in inorganic crystal structure databases for probable martensitic phase transition, where the crystal symmetry is chosen as descriptor for potential austenite (cubic symmetry) and martensitic (symmetry lower than cubic) compositions. For matching pairs, the potential austenite phase is assessed by appropriate density functional theory (DFT) calculations using temperature-dependent effective potentials with specific emphasize on identifying stoichiometric and non-stoichiometric compositions with crystallographic supercompatibility between the two phases. The proposed research bears highest potential for the development of new knowledge beyond the state-of-the-art on elastocaloric phase change materials with no fatigue in the elastocaloric cooling cycle including significant theoretical advancement regarding a screening procedure to uncover as yet unknown near-supercompatible elastocaloric materials. Advanced material synthesis combined with sophisticated structural characterization down to the atomic scale and functional characterization in thin films and bulk materials is sound and very challenging. The realization of materials with superreversibility due to optimized microstructure and their implementation into compositionally graded and cascaded devices with materials of slightly different phase transition temperatures by slight compositional variations is ambiguous and credible. The research questions are well described and based on clear hypotheses, and the project, multidisciplinary in nature, cleverly combines several theoretical and experimental methods. Five scientific packages are broken down to associated tasks. Potential risks are identified and measures to mitigate them are considered in detail.

Selected mark : 7 - Exceptional

The proposal addresses all relevant aspects of the criterion exceptionally well.
Shortcomings are not present, or only very minor.

Impact

Potential impact of the proposed research

- Potential for academic impact:

The extent to which the planned outputs of the project address important present and/or future scientific challenges.

- Potential for societal impact (if addressed by the applicant):

The extent to which the planned outputs of the project address UN Sustainable Development Goals or other important present and/or future societal challenges.

- The extent to which the potential impacts are clearly formulated and plausible.

Communication and exploitation

- Quality and scope of communication and engagement activities with different target audiences, including relevant stakeholders/users.

The planned output of the project addresses the essential scientific challenge to deliver a complete picture on elastocaloric phase change materials with academic impact on different scientific communities including materials science, solid state physics, metallurgy and computational, materials science. The methodology is suitable for discovering and characterizing previously unknown elastocaloric materials with no fatigue in the elastocaloric cooling cycle rendering possible reliable solid state cooling close to room temperature at a coefficient of performance, which could outperform state-of-the-art fluid-based cooling devices. Current cooling systems are based on technologies several decades old and are not very efficient. Efficient solid state cooling near ambient temperature is thus an extremely important societal goal.

Knowledge and outputs generated in the project can contribute to solving societal challenges related to several UN SDGs (3, 6, 7, 9, 11, 13). The potential impacts are clearly formulated and plausible, and a huge impact is foreseen. The quality and scope of communication and engagement activities with the different target audiences are exceptional. Knowledge gained will be protected and exploited through SINTEF's large and diverse contact sphere with industry.

Selected mark : 7 - Exceptional

The proposal addresses all relevant aspects of the criterion exceptionally well. Shortcomings are not present, or only very minor.

Implementation

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The quality of the project manager and project group

- The extent to which the project manager has relevant expertise and experience, and demonstrated ability to perform high-quality research (as appropriate to the career stage).
- The degree of complementarity of the participants and the extent to which the project group has the necessary expertise needed to undertake the research effectively.

The quality of the project organisation and management

- Effectiveness of the project organisation, including the extent to which resources assigned to work packages are aligned with project objectives and deliverables.
- Appropriateness of the allocation of tasks, ensuring that all participants have a valid role and adequate resources in the project to fulfil that role.
- Appropriateness of the proposed management structures and governance.

The project manager is a top level scientist and has extensive experience in the field and in managing research projects as well as demonstrated ability to perform high-quality research. The participants of the project group all have considerable track record in their chosen fields and have the necessary expertise and capabilities to fulfill their role and to drive the research appropriately. The project manager has assembled a quite impressive team, from a company (SINTEF) and the University of Oslo, as well as outside Norway (in Germany, Hong-Kong, the US and Sweden). All members of the team have a valid and complementary role in the project, which is described in the work packages. A very detailed table also shows how the tasks will be allocated to the project team members. The project is organized effectively in 6 work packages, which are presented in a Gantt chart with well-defined and adequate milestones. Resources are assigned to work packages, and they are appropriately aligned with the project objectives and deliverables. Overall, the implementation looks exceptional.

Selected mark : 7 - Exceptional

The proposal addresses all relevant aspects of the criterion exceptionally well.
Shortcomings are not present, or only very minor.

Overall assessment of the referee/panel

Overall assessment of the referee/panel based, on the criteria Excellence, Impact and Implementation.

The proposal is of exceptional quality and the highest international standard. The exceptionally well planned output of the project addresses an original and timely approach to screen a wide range of binary and ternary alloys and intermetallics with supercompatible elastocaloric martensitic phase transition. The proposed research bears highest potential for the development of new knowledge beyond the state-of-the-art on elastocaloric phase change materials with no fatigue in the elastocaloric cooling cycle including significant theoretical and experimental advancement regarding material synthesis combined with sophisticated structural and functional characterization in graded thin films and cascaded bulk materials. The methodology is suitable for discovering and characterizing previously unknown elastocaloric materials with no fatigue in the elastocaloric cooling cycle. The subject of the proposal is ambitious and of importance for reliable solid state cooling close to room temperature at a coefficient of performance, which could outrival state-of-the-art fluid-based cooling devices in terms of energy efficiency. The participants of the project group all have considerable track record in their chosen fields and have the necessary complementary expertise and capabilities to fulfill their role and to drive the research appropriately. The societal impact from the development of proposed solid state cooling device and the developed elastocaloric materials can be expected for the sectors of "good health and quality of life", "clean water and good sanitation", "clean energy for all", "stop climate change", "industry, innovation and infrastructure" and "sustainable cities and communities". The impact is huge.

Selected mark : 7 - Exceptional

The proposal is of exceptional quality, and of the very highest international standard. All relevant aspects of the criteria are exceptionally well addressed. Shortcomings are not present, or only very minor.

Special points to consider

Comments to special points to consider