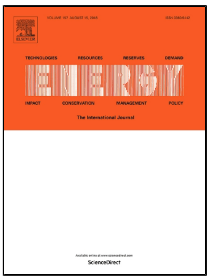
Accepted Manuscript



Phase-changing materials for thermal stabilization and thermal transport

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PII:	S0360-5442(18)31547-0
DOI:	10.1016/j.energy.2018.08.027
Reference:	EGY 13503
To appear in:	*Energy*
Received Date:	24 January 2018
Accepted Date:	03 August 2018

Please cite this article as: Krašna Marjan, Klemenčič Eva, Kutnjak Zdravko, Kralj Samo, Phase-changing materials for thermal stabilization and thermal transport, *Energy* (2018), doi: 10.1016/j.energy.2018.08.027

Phase-changing materials for thermal stabilization and thermal transport

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Abstract

We consider systems exhibiting a temperature driven thermodynamic first order phase transition in orientational ordering. The latent heat is released (absorbed) on entering (exiting) the low temperature phase and this mechanism could be exploited for thermal stabilization. Namely, during the phase transition the temperature remains constant. Furthermore, if orientational ordering can be manipulated by an external electric field E the electrocaloric effect (ECE) could be observed. It describes the heating or cooling of an electrocaloric material triggered by adiabatically switching E on or off. In the paper we use the Landau-type mesoscopic approach to present minimal modelling revealing how material exhibiting continuous symmetry breaking discontinuous phase transition could be used for such purposes. We demonstrate how the phase transition temperature could be tuned to a desired value for systems described with i) vector, ii) tensor nematic, and iii) complex order parameter. In studying ECE we compare responses of systems which are coupled linearly and quadratic with E. Our modelling reveals parameters that dominantly influence the magnitude of ECE response. The results of our study could pave the way in discovering new tunable temperature isolating and high performance ECE materials.

Keywords

Thermal stabilization, electro caloric effect, cooling devices, phase transitions, order parameter

1. Introduction

Contemporary society demands more and more energy. The price of energy becomes factor that guides many decisions in short, medium and long-term strategies of companies and states. The use of renewable energy and energy storage systems are important because we need to control and reduce the carbon dioxide emission [1]. The society, researchers, and product manufacturers should find the way to optimize the energy consumption [2-8].

One possible path to reduce energy consumption and use environment friendly approaches is to exploit extraordinary properties of phase change material [9, 10]. In a discontinuous phase transition [10, 11] the