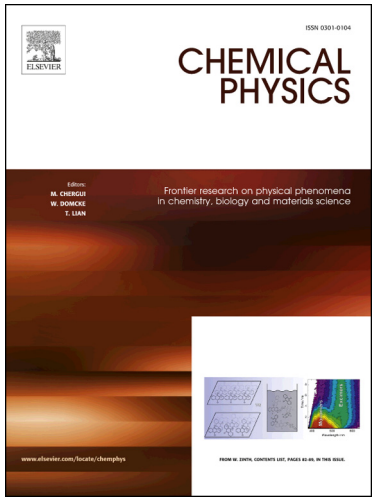

Molecular thermal transistor: Dimension analysis and mechanism

S. Behnia, R. Panahinia

PII: S0301-0104(17)30653-5
DOI: https://doi.org/10.1016/j.chemphys.2018.02.018
Reference: CHEMPH 9942

To appear in: *Chemical Physics*

Received Date: 9 August 2017
Accepted Date: 18 February 2018

Please cite this article as: S. Behnia, R. Panahinia, Molecular thermal transistor: Dimension analysis and mechanism, *Chemical Physics* (2018), doi: https://doi.org/10.1016/j.chemphys.2018.02.018

Molecular thermal transistor: Dimension analysis and mechanism

S. Behnia , R. Panahinia

Department of Physics, Urmia University of Technology, Urmia, Iran

Abstract

Recently, large challenge has been spent to realize high efficient thermal transistors. Outstanding properties of DNA make it as an excellent nano material in future technologies. In this paper, we introduced a high efficient DNA based thermal transistor. The thermal transistor operates when the system shows an increase in the thermal flux despite of decreasing temperature gradient. This is what called as negative differential thermal resistance (NDTR). Based on multifractal analysis, we could distinguish regions with NDTR state from non-NDTR state. Moreover, Based on dimension spectrum of the system, it is detected that NDTR state is accompanied by ballistic transport regime. The generalized correlation sum (analogous to specific heat) shows that an irregular decrease in the specific heat induces an increase in the mean free path (mfp) of phonons. This leads to the occurrence of NDTR.

Keywords: Thermal transistor, DNA, Multifractal analysis, Mean free path, Specific heat.

1. INTRODUCTION

Systems in nanoscales have confronted with significantly different transport properties because of size effects. These differences reveal interesting and desirable behavior which is a key to future nanotechnology engineering. Provided by size effects, various energy control devices have been reported such as field effect transistors (FET) [1, 2], thermal transistors [3] and thermoelectric transistors [4]. FETs have impressed all aspects of our daily lives.

Email address: s.behnia@sci.uut.ac.ir (S. Behnia)