Accepted Manuscript

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 PII:
 S0022-247X(18)30582-1

 DOI:
 https://doi.org/10.1016/j.jmaa.2018.07.006

 Reference:
 YJMAA 22397

To appear in: Journal of Mathematical Analysis and Applications

Received date: 29 January 2018

Please cite this article in press as: P. Guzmán, Energy decay of a microbeam model with a locally distributed nonlinear feedback control, *J. Math. Anal. Appl.* (2018), https://doi.org/10.1016/j.jmaa.2018.07.006

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Energy decay of a microbeam model with a locally distributed nonlinear feedback control

Patricio Guzmán*

Abstract

In this paper we address the problem of internal stabilization of the deflection of a microbeam, which
is modeled by a sixth-order hyperbolic equation. Employing multiplier techniques and an integral
inequality, we prove that a locally distributed nonlinear feedback control forces the energy associated
to the deflection to decay exponentially or polynomially to zero. As a consequence of this, the deflection
goes to the rest position as the time goes to infinity.

2010 Mathematics Subject Classification: 35B40, 35L35, 74K10, 93B52.

11 **Keywords:** Microbeam model, hyperbolic equation, internal stabilization, locally distributed 12 nonlinear feedback control, exponential energy decay, polynomial energy decay.

13 **1** Introduction

A microbeam is a beam whose dimensions are in the order of a few microns. According to [26, Chapter 6], the microbeams are perhaps the most common structural component used in microelectro-mechanical systems (MEMS) such as actuators, filters, resonators and sensors.

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The deflection z = z(t, x) of a clamped microbeam of density $\rho > 0$, cross-sectional area A > 0, Young's modulus E > 0, area moment of inertia I > 0, shear modulus G > 0 and length L > 0 being subjected to a distributed load f = f(t, x) can be modeled by

$$\rho Az_{tt} + M_1 z_{xxxx} - M_2 z_{xxxxxx} = f, \quad (t, x) \in (0, \infty) \times (0, L),
z(t, 0) = z_x(t, 0) = z_{xx}(t, 0) = 0, \quad t \in (0, \infty),
z(t, L) = z_x(t, L) = z_{xx}(t, L) = 0, \quad t \in (0, \infty),
z(0, x) = z_0(x), \quad x \in (0, L),
z_t(0, x) = z_1(x), \quad x \in (0, L).$$
(1.1)

This model has been derived in [12, Section 3] and [17, Section 4] by using the modified strain gradient elasticity theory developed in [19, Section 2] together with Hamilton's Principle. Here

$$M_1 = EI + GA\left(2l_0^2 + \frac{8}{15}l_1^2 + l_2^2\right)$$
 and $M_2 = GA\left(2l_0^2 + \frac{4}{5}l_1^2\right)$,

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