TSINGHUA SCIENCE AND TECHNOLOGY
ISSN 1007-0214 14/23 pp216-220
Volume 10, Number 2, April 2005

Mechanical Characteristics of Oil-Damping Shock Absorber for Protection of Electronic-Packaging Components*

YANG Ping (杨 平)**

**Research Center of Micro-Nano Science and Technology, Jiangsu University, Zhenjiang 212013, China;
Research Center of Advanced Design and Manufacturing, Guilin Institute of Electronic Technology, Guilin 541004, China**

Abstract: A microstructure oil-damping shock absorber was designed for the protection of electronic-packaging components in vibration-impact environments. The nonlinearity of the oil viscosity, the oil flow characteristics, and the coupling between the oil and the physical structure were included in a mathematical model of the oil-damping shock absorber to attenuate vibrations. The results of multi-parameter-coupled dynamic tests show that the mathematical model accurately simulates the actual physical system of the oil-damping shock absorber. The model could be used for engineering designs of vibration-impact isolation of electronic-packaging components.

Key words: oil-damping shock absorber; damping characteristics; electronic-packaging components; packaging

Introduction

Research on the design of shock absorbers to improve the dynamic characteristics of electronic information equipment in moving vehicles has rapidly increased in recent years. Most designs include a vibration isolator or shock absorber to moderate violent impacts and to attenuate vibrations so as to improve vibration-impact safety. An accurate characterization of the shock absorber is of paramount importance for sufficiently precise mathematical models of the shock absorber or vibration isolator for design purposes[1-12].

This paper describes a new shock absorber, the micro-oil-coupled shock absorber with oil damping with coupling among the oil, the rubber, and the spring that is designed to resist violent impact and to attenuate vibrations in electronic information equipment. The shock absorber damping force is strongly nonlinear in dynamic vibration tests. Physical tests of a shock absorber were used to understand the nonlinear phenomena occurring within the shock absorber.

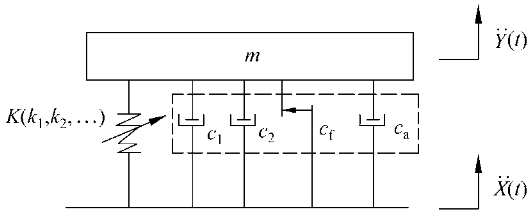
1 Description of Physical Structure and Model of the Micro-Oil-Coupled Shock Absorber

Figure 1 shows a mechanical model of the micro-oil-coupled shock absorber. Two types of oil-damping structures were designed for the oil-damping, the first was a damping pot, which circulates oil between inner and outer tubes with orifices in the inner tube. The second structure was a piston damper with a piston in a cylinder containing a rebound chamber and a compression chamber with orifices in the piston. Both structures were used in the micro-oil coupled shock absorber.

Received: 2003-05-02

∗ Supported by the Natural Science Foundation of the Guangxi Zhuang Autonomous Region (Nos. 0339037 and 0141042), the National Defense Science Foundation of China (No. 00J16.2.5.DZ 0502), the National Science Foundation of Jiangsu University (No. 04JDG027), and the Innovative Science Foundation of Jiangsu University

∗∗ E-mail: yangpingdm@ujs.edu.cn; yangping1964@163.com



$K(k_1, k_2,...)$, nonlinear stiffness; c_1, c_2, c_f, c_a, viscous, quadratic, Coulomb, and additional damping coefficients

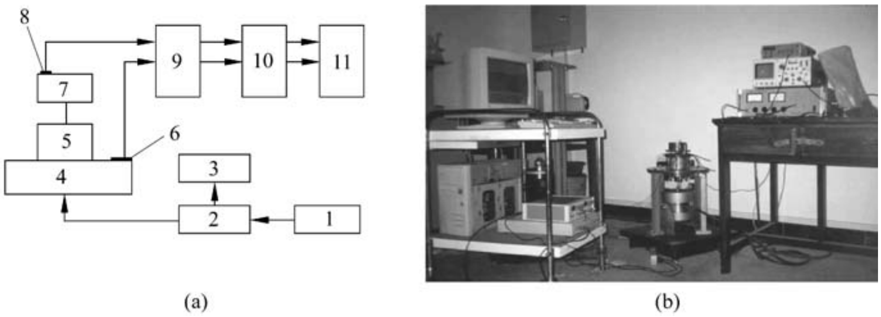
Fig. 1 Mechanical model of the micro-oil-coupled shock absorber

2 Test of the Shock Absorber Working Characteristics

Figure 2a shows a scheme of the experimental setup with a picture of the test system in Fig. 2b. The vibration attenuation of the shock absorber was tested by the system. The shock absorber was mounted on an electrodynamic shaker, with the lower end fixed to the vibrating table of the shaker and the opposite end attached to a mass. The signal producer and power amplifier in Fig. 2a were used to control the shaker, while the time histories of the input and output state variables were measured by the two accelerometer sensors and a data acquisition system. The oscilloscope was used to observe all the signal components.

Large amounts of test data were measured for the shock absorber filled with hydraulic oil. The tests investigated the influence of the amplitude and frequency of the sine excitation, as well as the influence of fluid viscosity, oil damping area ratio, and additional damping forces and friction.

Figures 3 and 4 illustrate some of the measured damping forces. The curves are presented as damping force versus relative velocity and relative displacement to clearly show the effect of the sine excitation. Comparing Figs. 3 and 4 shows that the nonlinear effect changed as the excitation frequency increased with the higher-frequency giving lower output at the maximum velocity point. The test results show that



1, Signal producer; 2, Power amplifier; 3, Oscilloscope; 4, Electrodynamic shaker; 5, Shock absorber; 6 and 8, Accelerometer sensors; 7, Mass; 9, Electricity amplifier; 10, Data acquisition equipment; 11, Computer

Fig. 2 Experimental setup

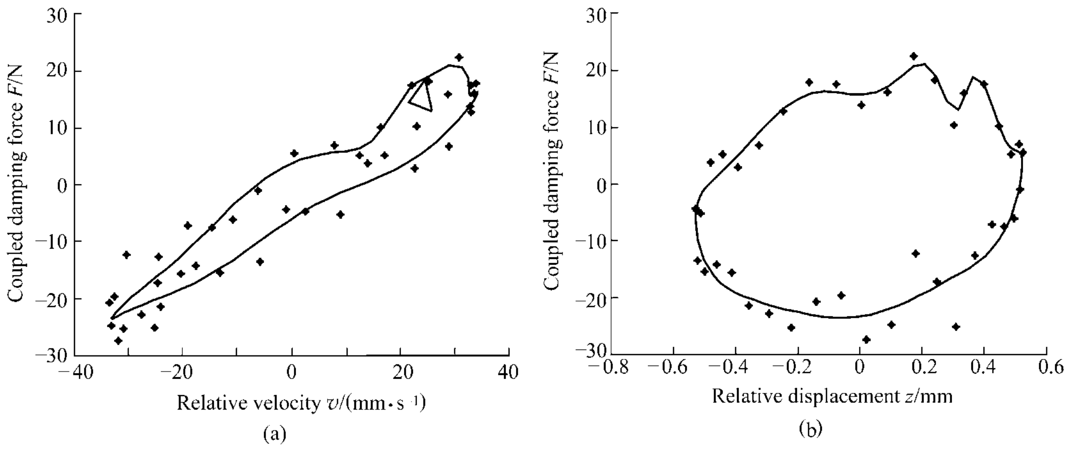


Fig. 3 Damping force variations for a sine excitation frequency of 10 Hz