

Sensitivity analysis of pico and femto sliders

J. Zhang, F. Talke

Center for Magnetic Recording Research, University of California, San Diego, CMRR 0401, La Jolla, CA 92093, USA

Received 3 December 2001; accepted 6 November 2002

Abstract

The flying height sensitivity of pico and femto sliders on air bearing contour design, operating conditions and manufacturing tolerances was studied numerically. A Monte Carlo analysis was performed to evaluate the distribution of flying height, pitch angle and roll angle, assuming the selected independent variables have normal distributions. Two types of pico sliders and one type of femto sliders were modeled and simulated. The results show that flying height is strongly influenced by the contour design of the air bearing slider. The resulting distributions of flying height, pitch angle and roll angle are near Gaussian.

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1. Introduction

As the magnetic recording density in hard disk drives approaches 100 Gbit/in², the requirements for hard disk drives become increasingly more stringent. In particular, a small and stable spacing lower than 10 nm must be maintained. For sliders flying at such low spacing, it is important that the flying height is insensitive to the manufacturing tolerances and changes in the operating conditions. This paper studies the effect of manufacturing tolerances on the flying behavior of pico and femto sliders using a finite element based air bearing simulator.

Flying height was measured experimentally using a commercially available dynamic flying height tester (DFHT). Good agreement is obtained between simulation results and experimental measurements.

2. Slider design and mesh generation

Two types of low flying proximity pico sliders were investigated. The first is a subambient pressure tri-pad slider, denoted slider I, and the second is a subambient

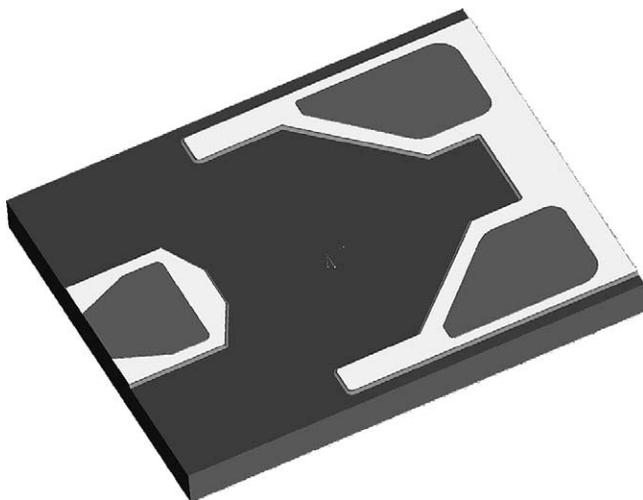


Fig. 1. Air bearing surface design of slider I.

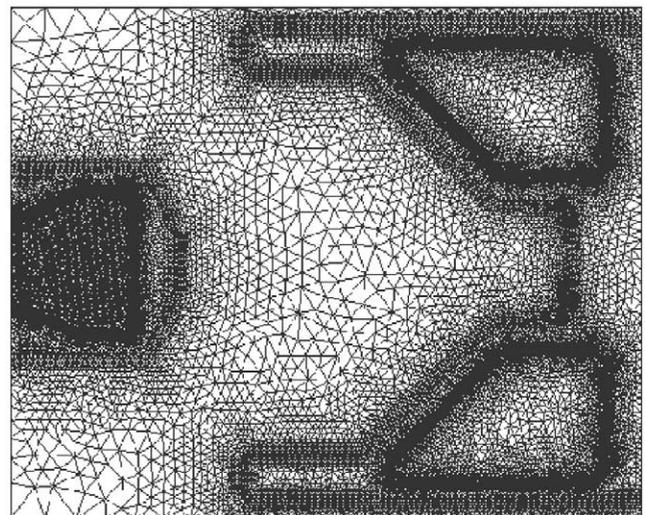


Fig. 2. Finite element mesh for slider I # Nodes: 23547 # Elements: 46770.

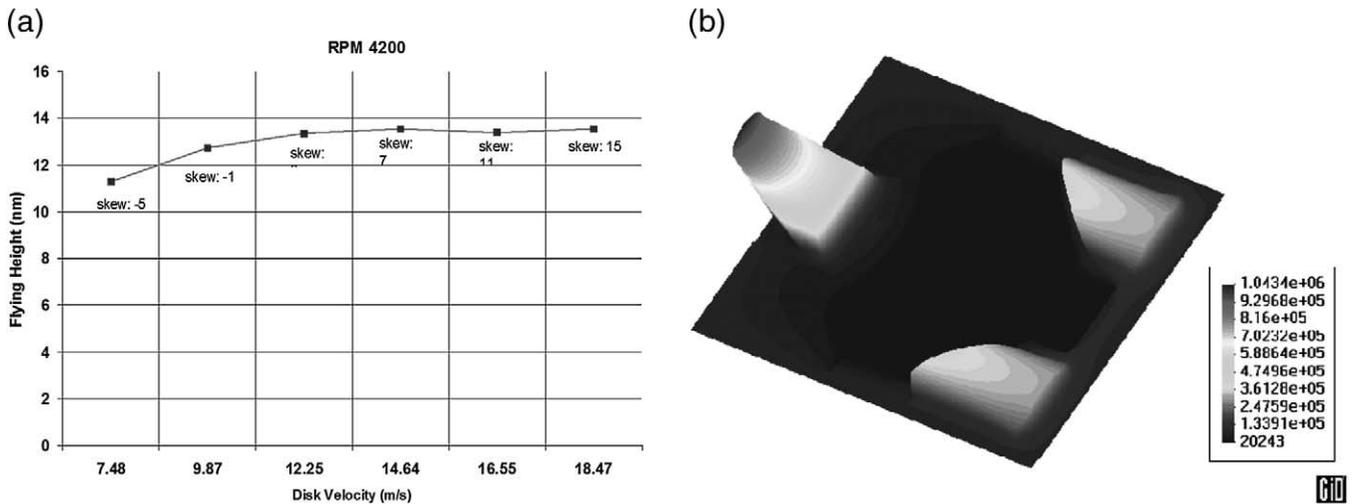


Fig. 3. Typical simulation results of slider I.

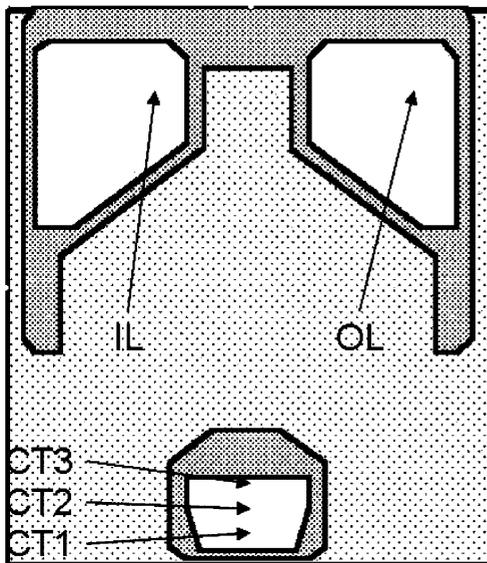


Fig. 4. Slider I flying height measurement setup.

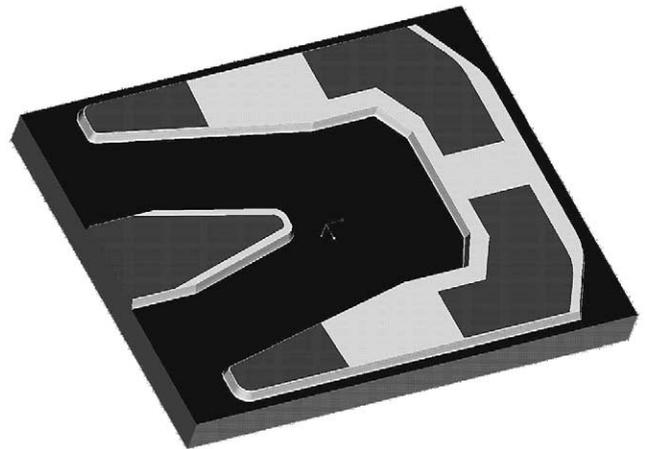


Fig. 5. Air bearing surface design of slider II.

Table 1
Slider I flying height measurement results

Slider(No.)	Radius(mm)	Skew(°C)	RPM	Velocity(m/s)	CT1(nm)	CT2(nm)	CT3(nm)	IL(nm)	OL(nm)
1	45.00	0.00	2970	13.996	16.892	19.775	24.188	65.471	86.081
2	45.00	15.00	2970	13.996	16.144	19.260	21.070	58.659	74.283
3	45.00	15.00	2970	13.996	13.557	16.301	19.029	66.840	71.917

Table 2
Design parameters of femto sliders

Slider size	%	L (mm)	W (mm)	T (mm)	No. sliders in a 6" wafer	Load (N)
Femto	20	0.85	0.7	0.23	45000	0.005–0.015

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