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Study of Biocompatible Anti-adhesive Films on SiC Surfaces with Different Roughness Directions and Values

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Extended Abstract

MEMS is often impeded by excessive adhesion forces arising during fabrication or operation caused by small restoring forces creating a microtear from the reduced structure stiffness. Adhesion in MEMS, commonly referred to as stiction, is a result of the dominance of surface forces over body forces at the micro-scale, as shown by Ashurst et al. (2003). Therefore, how to improve the adhesion performance between surfaces becomes an attractive task in MEMS to enhance device reliability, as shown by Larsson et al. (2005). SiC film is often used in MEMS devices due to low friction and superior scratch and wear resistance. However, its adhesion properties must be enhanced to meet the excessive adhesion requirement of the moving parts of MEMS devices. Surface modification of metals using self-assembled monolayers (SAMs) has potential applications in biosensors, bioactive surfaces, drug delivery, organic electronic devices and so on, because of their ease of preparation, as shown by Mani et al. (2008). Octadecyltrichlorosilane (OTS) and Octadecyltrimethoxysilane (ODS) are one of the extensively studied self-assembled monolayer for biological applications. This study used biocompatible OTS and ODS films to examine the adhesion performance for different roughness directions and roughness values of SiC surfaces.

The silicon wafers in this study have two directions of roughness on their surface: a straight roughness pattern and a cross roughness pattern. Roughness value of surface was classified as smooth (Ra: 80 nm-95 nm), a small amount of roughness (Ra: 150 nm-200 nm), and a large amount of roughness (Ra: 300 nm-350 nm). The wafers were then coated with SiC and bathed with OTS or ODS film. OTS and ODS were dissolved in alcohol and prepared to a molar concentration of 10 mM. The test pieces were placed in the solution at a bath temperature of 80 ℃, bath duration of 12 hr, a drying temperature of 55 ℃, and a drying time of 10 min. The test pieces were then removed and set aside for 12 hr before being sonicated for 2 min and blown dry with nitrogen gas.

Experimental results show that all of two biocompatible films can increase significantly the contact angle of all SiC surface topographies, from 60^{o} to 120^{o} for OTS film and 110^{o} for ODS film, which effectively reduces device adhesion force. The various surface roughness values and directions of the SiC surface have little effect on the adhesive force of OTS and ODS films. For all film materials on the different surface topographies, larger normal forces lead to smaller friction coefficients. In addition, OTS film can decrease the friction coefficient on cross topography more effectively than that on straight topography and ODS film on all surface topographies.

References

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