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MICROTRIBOLOGICAL PROPERTIES OF FLUORINATED AMORPHOUS CARBON COATINGS

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The strong influence of surface forces is a cause of concern in microelectromechanical systems (MEMS). The high adhesion and friction that result from the effect of surface forces often lead to reduced reliabilities during operation and even device failure. Due to the significant technological potential of MEMS, there have been many efforts to find viable solutions. The use of hydrophobic surfaces, like for example, H-terminated silicon surfaces, self assembled monolayers and Langmuir-Blodgett films have shown promising results. In microsystem applications where low energy surfaces with favorable mechanical properties are required, fluorinated amorphous carbon coatings may play an important role. However, their microtribological properties need to be thoroughly understood.

Reported here are experimental results from different types of thin fluorinated amorphous carbon (a-C:H:F) coatings, that were grown from $CH_4/CF_4/Ar$ gas mixtures using a 13.56 MHz radiofrequency pulsed plasma source. A reciprocating microtribometer was used to study the microadhesion and microfriction properties of these coatings. Nanoindentation measurements were also performed to understand the mechanical properties of the coatings, especially the effect of pulsed plasma frequency on the tribological and mechanical properties of the coatings. Raman spectroscopy and X-ray photoelectron spectroscopy (XPS) were exploited to study the structural, vibrational properties and chemical composition of the coatings. Raman measurements suggest that, for a fixed plasma composition, with increasing plasma frequency from 10 to 1000 Hz, film microstructure changed from polymer-like to diamond-like. Improvement in the microtribological properties was found in a-C:H:F samples deposited with the highest plasma frequency. Adhesion and microfriction measurements (friction-load curves and velocity dependence) show a dependence on the plasma source frequency, which is attributed to the amount of fluorine incorporation in the coatings. The velocity dependence as well as humidity sensitivity of the fluorinated coatings was also determined. The microtribological behavior of these coatings is compared to H-terminated silicon surfaces and self assembled monolayer films.

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