Micromachined Shear Stress Sensors for Characterization of Surface Forces During Chemical Mechanical Polishing

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Technology description

Summary

Tufts University Categories:
semiconductor:lithography
semiconductor:MEMs
semiconductor:processing
sensors

Invention Summary

Background:

As feature sizes in the semiconductor industry continue to shrink, the importance of planarizing substrates both globally and locally grows. Chemical mechanical planarization (CMP) is now the foremost nanomanufacturing process worldwide. It has an annual economic impact over $1 billion and individual CMP processes are well established within certain enterprises. Still, the ability to change CMP parameters and predict the effect this will have on material removal rates is not yet realized. The CMP process is widely used and removal rates for certain systems have been characterized experimentally in terms of many of the polishing parameters, but a comprehensive model involving all variables and their effects on material removal rate and non-uniformity is lacking.

Due to this limited understanding of a very important process, it is important to have as much in situ measurement data as possible. This is useful in a production environment to be able to detect normal aging of the polishing pad or conditioner to know when to change them. It would also be useful for detecting unexpected conditions that would result in a poor polish which could result in loss of product.

Invention:

The invention consists of an array of micromachined shear stress sensors. Each shear stress sensor in the array is a poly-dimethyl-siloxane (PDMS) post-in-well Âµm scale structure. It is intended for characterization of the local pad-wafer contact forces present during chemical-mechanical polishing. Forces acting at the tips of the posts cause deflection of the tip. This deflection is measured optically by a high speed camera, integrated with a microscope objective, relay lens, beam splitter, and fiber optic light source attached mechanically to the polishing rig. Real-time images are captured at 10,000 frames per second. Sensors are able to measure forces ranging from 4 to 400 ÂµN.

Advantages

The major advantages of the design are: (1) the small size, allowing high spatial resolution (2) the high resonant frequency and camera rate, allowing high temporal resolution (3) the chemically and electrically inert nature of the structure, allowing it to be used in the polishing environment.

Institution

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