The stable immobilization of proteins on surfaces is a key issue for a
Such applications require that proteins be oriented in a way that their active
sites are free to bind other molecules. In the past, different gold surfaces have
been investigated as protein supports, since it was discovered that proteins
with free cysteine can form strong gold-sulfide bonds. However, proteins
deposited on gold surfaces tend to form monolayers, and thus large areas
within the proteins are hidden. We have succeeded in immobilizing isolated
proteins on a graphite surface decorated with size-selected gold clusters
deposited from a cluster-beam source [Nature Materials 2 443 (2003)]. This
approach is now being exploited in the development of a novel biochip for
protein screening by a spin-off company. Nonetheless, many fundamental
questions remain. Experimentally, there are several challenges to examine
the structure of the immobilized proteins; X-ray-diffraction microscopes cannot
be employed since the proteins are isolated, while STM distorts the protein
structure. On the other hand, modeling can provide an attractive approach
to obtain an idea of the structure and binding of an isolated protein
immobilized on a surface. In our theoretical approach, we employ a QM-MM
approach developed by us [J. Phys. Chem. B 107, 13728 (2003)] that combines
the SIESTA methodology (DFT approach) with an empirical force field. In this
sense, we address the nature of the interaction between a human oncostatin
M (OSM) molecule and an Au75 cluster pinned on a graphite surface. For
instance, we show that the cysteine residues of OSM can form strong bonds
with the surface atoms of the gold cluster. The orientation and structure of
the adsorbed protein is analyzed. QM/MM results are compared with
experimental data.

### Oral Presentation O17-7

**Simulation and Fabrication of a Mechano-Optical Sensor for Nano-Displacements**


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We present the simulation and fabrication of a novel and highly sensitive mechano-optical sensor for nano-displacements, based on
microcantilevers suspended above a Si3N4 grated waveguide (GWG). The
presence of a dielectric object, in this case a suspended cantilever, in the
evanescent field region of the GWG may lead to the occurrence of
propagating modes for wavelengths inside the stop band of the grating, and
so to resonances (defect modes) inside the stop band.

The 2D bidirectional eigenmode propagation (BEP) method has been
applied to analyze the effect of cantilever displacement on the optical
transmission spectrum of the GWG. The simulation results show that as the
cantilever approaches the grating, the first near band-edge resonance peak is
pulled inside the stop band and its spectral width decreases. The resolution
of displacement measurement is estimated to be 0.2 nm for a 200 nm thick
cantilever at a 200 nm initial gap, assuming a signal-to-noise ratio (SNR) of
20 dB.

Integrated microcantilever-GWG devices have been fabricated successfully
using MEMS techniques. Uniform gratings have been defined with
laser interference lithography. SiO2 cantilevers with low initial bending (i.e.,
low stress) have been fabricated by combining the tetra-ethyl-ortho-silicate
chemical vapor deposition (TEOS-CVD) and plasma-enhanced chemical
carbon deposition (PCVD) oxides, and by releasing them using a
tetramethylammonium hydroxide (TMAH) wet-etching solution, followed by
a freeze-drying process. High-resolution-SEM and AFM measurements
revealed that the initial bending of 30 μm long cantilevers is as low as 250
2.3 μm long cantilevers is as low as 250
μm. Additionally it was found that TMAH etching improved the quality of the
guides by reducing surface roughness from 1.41 nm down to 0.46 nm. The
measured stop band of the GWG agrees well with the calculated result.

The simulation, successful fabrication, and initial optical
characterization results demonstrate the potential of the integrated
microcantilever-GWG as a novel and compact mechano-optical sensor for
nano-displacements.

### Oral Presentation O17-8

**Electrochromic Nanoparticle Ink: Displays and Color-Switchable Glasses Fabricated by Liquid Processes**

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Color-switchable devices, such as displays and color-switchable glasses,
have been fabricated by means of the "electrochromic nanoparticle ink" by liquid
processes.

For the electrochromic ink, we have developed the new method to
synthesize the nanoparticles of Prussian blue (PB) and its analogues. With
our synthesis, dense "ink" of the PB nanoparticles, e.g. 0.1 g/ml, can be
obtained. Consequently, various conventional coating and printing methods
can be used in high-quality micro-fabrication. In addition, multi-color device
is possible by means of the PB analogs having various colors.

The electrochromism of the PB nanoparticle films fabricated by spin-
coating on a transparent conducting oxide (TCO) was observed: the color
changes between blue and transparent reversibly by applying voltage. The
electrical-color-switchable glass with electrolyte sealed between opposed
two TCOs with was fabricated, exhibiting electrochromism only with a 1.5 V
dry battery even after operations of 105 times.

Various patterns of the nanoparticle thin film can be also printed on
substrates using photolithography or inkjet printing techniques. For example,
we have developed a display device switchable between different
two patterns electrically. This device exhibits very fast response, less than 200 ms.

This project was supported by the Industrial Technology Research
Grant Program, NEDO, Japan.