O 34 Particles and clusters II

Time: Thursday 11:15–13:00 Room: WIL A317

O 34.1 Thu 11:15 WIL A317

Supported Ag clusters deposited on insulating substrates studied by reflectance-difference spectroscopy and ellipsometry — •J.M. Flores-Camacho, L.D. Sun, M. Hohage, K. Schmidegg, N. Saucedo-Zeni, G. Weidlinger, and P. Zeppenfeld — Institute of Experimental Physics, Johannes Kepler University Linz, Altenberger str. 69, A4040 Linz, Austria

Metal clusters were formed during the deposition of nominally few nanometer thick Ag layer on insulating substrates, i.e., poly(ethylene terephthalate) (PET) and amorphous quartz. Depending on the cluster size, substrate crystallinity, and substrate dielectric properties, the metal clusters exhibit different plasmon related optical responses with out-of-plane and even in-plane anisotropy. In the case of clusters deposited on biaxially drawn PET substrates, reflectance-difference spectroscopy (RDS) provided a tool for the study of anisotropic plasmon resonances lying in the plane of the substrate. On the other hand, since Ag clusters on amorphous substrates such as quartz do not show in-plane anisotropy, then the out-of-plane anisotropy plays a prominent role in the determination of the cluster properties, therefore, the employment spectroscopic ellipsometry (SE) is proposed to accomplish such a task. This enables us to study plasmon resonances along both parallel and perpendicular directions to the substrate surface normal.

O 34.2 Thu 11:30 WIL A317

Photodesorption NO from silver nanoparticles on a thin alumina film — •Kazuo Watanabe[1], Ki-Hyun Kim[1], Dietrich Menzel[1,2], and Hans-Joachim Freund[1] — [1]Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, 14195 Berlin, Germany — [2]Physik-Department E20, Technische Universität München, 85747 Garching, Germany

The photodesorption (PD) of NO adsorbed on Ag nanoparticles supported on a thin Al_2O_3 film has been studied by a mass selected time-of-flight method (MS-TOF) and by temperature programmed desorption (TPD). NO was adsorbed on 0.5-nm deposited Ag nanoparticles (∼8 nm particle diameter) at 75 K. NO TPD showed two peaks at 75 K and 96 K due to desorption from NO dimers. NO adsorbates were photodesorbed by nanosecond laser pulses at $h\nu$= 3.5 and 4.0 eV. PD cross sections were obtained from the fluence dependence of the integrated TOF signals of desorbing NO. By fitting the data with a single exponential, cross sections of 7.1×10^{-17} and 8.4×10^{-17} cm^2 were obtained for the two energies. This corresponds to enhancement factors of 37 and 1.6 compared to those on Ag(111) at $h\nu$=3.5 and 4.0 eV, respectively. The large enhancement at 3.5 eV is explained by resonant excitation of the Mie plasmon of the Ag nanoparticles. Mean translational energies of NO were 700 K and 800 K at $h\nu$=3.5 and 4.0 eV, respectively; they increased to more than 1000 K for extended photoirradiation. These values are considerably larger than that from Ag(111): ∼490 K at $h\nu$=3.5 eV. The increase of translational energies of photodesorbed NO from silver nanoparticles may be attributed to longer lifetimes of the active excited states of NO.

O 34.3 Thu 11:45 WIL A317

Plasmon excitations in clusters in the vicinity of metal surfaces — •Yaroslav Pavlyukh and Wolfgang Hübner — Department of Physics, Kaiserslautern University, Box 3049, D-67653, Kaiserslautern, Germany

We study the collective excitations of metal clusters approaching a metal surface. Using a simple model for the frequency-dependent dielectric constant $\varepsilon(\omega)$ and the multiple scattering method we numerically investigate the shift in the plasmon resonance due to the coupling of the collective modes of the sphere with those of its mirror image. Results of the model calculation are verified by means of *ab initio* theory. As a prototypic system we study Na_9^+ cluster on the Cu (100) surface. The representation of the solid surface by a cluster of several, typically 54 substrate atoms is used in the combination with a high level configuration interaction (CI) calculation.

O 34.4 Thu 12:00 WIL A317

Radiation damping of plasmons in metal nanoparticle pairs — •Christian Dahmen, Benjamin Schmidt, and Gero von Plessen — Nanostructure Optics Group, I. Physikalisches Institut (IA), RWTH Aachen, 52056 Aachen

The optical properties of electromagnetically coupled metal nanoparticles have received much interest. This interest is partially fuelled by the large local-field enhancement near coupled nanoparticles, which plays an important role in surface-enhanced Raman scattering. Another point of interest are the spectral properties of the coupled particle-plasmon resonances. They show large frequency shifts when the particle spacing is sufficiently small for near-field coupling to occur. Less attention has been devoted to the issue of radiation damping in coupled nanoparticles. Here we calculate the radiation damping rates of plasmon resonances in metal nanoparticle pairs using Generalized Mie theory, which takes retardation effects into full account. The radiation damping of the coupled particle-plasmon mode alternates between superradiative and subradiative behavior when the partice spacing is varied. The damping thus depends on the phase difference between the dipole of one particle and the field scattered by the other particle. At small particle spacings where near-field coupling sets in, the radiation damping rate lies far below that of an isolated particle. This reduction of radiation damping implies a reduced dephasing of the coupled plasmon mode and thus tends to increase the local field enhancement in the space between the particles.

O 34.5 Thu 12:15 WIL A317

Optical and structural changes of embedded silver nanoparticles during photochromic transformation — •Christian Dahmen, Alexander N. Sprafke, Henning Dieker, Florian Hallermann, Matthias Wuttig, and Gero von Plessen — I. Physikalisches Institut (IA), RWTH Aachen, 52056 Aachen

Photochromic materials reversibly change their color under light illumination. We have recently reported that dc-sputter deposition can be employed to prepare a multicolor photochromic material consisting of silver nanoparticles embedded in TiO_2. The explanation for photochromism in this system is spectral hole burning in the inhomogeneously broadened particle-plasmon band, which is probably caused by photoemission of electrons from the Ag nanoparticles. In this work, we investigate how the particle-plasmon line of optically excited silver nanoparticles is modified to give rise to the photochromic effect. We find that the spectral hole is mainly due to a reduction of the plasmon extinction peak of the excited nanoparticles. From a comparison with x-ray diffraction experiments we conclude that this decrease of the extinction peak is caused by a photoinduced reduction of the mean size of the silver nanocrystals.

O 34.6 Thu 12:30 WIL A317

Characterisation of silver nanoparticles on magnesium oxide — •M. Alschinger[1], Y. Chen[2], M. Di Vece[2], F. Hubenthal[1], R.E. Palmer[2], and F. Träger[1] — [1]Institut für Physik, Universität Kassel, Kassel — [2]Nanoscale Physics Research Laboratory, The University of Birmingham, Birmingham, UK

Determination of the dimensions of supported nanoparticles has long been a very important issue that can most reliably be accomplished by transmission electron microscopy (TEM). Such measurements are, however, time consuming and require laborious preparation of the samples. In order to develop a more straightforward, easy to apply and accurate alternative, optical spectroscopy and its potential for the determination of the particle size and shape has been examined in detail here. The results were complete by AFM images and compared to data derived from TEM pictures. First, Ag nanoparticles have been prepared in vacuum by deposition and nucleation of silver atoms on magnesium oxide substrates. Subsequently, the optical spectra were recorded and compared to theoretical spectra based on the quasistatic approximation in order to establish a relation between the size and shape of the particles. AFM has been used to measure the size and the size distribution of the particles. In a second step the same kind of particles was prepared for TEM experiments from which we could obtain precise data for comparison. The most important result is that modelling of the optical spectra revealed a relation between the size and shape of the particles that is in accord with the TEM results and therefore forms a basis for reliable determination of the dimensions of nanoparticles by measuring their optical spectra.

O 34.7 Thu 12:45 WIL A317

Setup for the Study of Mass Selected Clusters at Surfaces with Low-Temperature STM and UPS — •Stefanie Krause[1], Thomas Irawan[1], Markus Bieletzki[1], Heinz Hövel[1], Chunrong Yin[2], and Bernd von Issendorff[2] — [1]Universität Dortmund, Experimentelle Physik I, 44221 Dortmund, Germany — [2]Universität Freiburg, Fakultät für Physik, 79104 Freiburg, Germany

We measure mass spectra of size selected Ag clusters with a cluster machine consisting of a magnetron sputter gas aggregation source [1], a differential pumping stage with a cryo pump and a high transmission infinite range mass selector [2]. In current experiments we extend these studies to the deposition of mass selected clusters on rare gas layers and different substrate systems. For these samples low-temperature STM and UPS [3] will be compared with photoelectron spectoscopy for the same clusters in a free cluster beam.

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[3] H. Hövel, T. Becker, D. Funnemann, B. Grimm, C. Quitmann and B. Reihl, J. Electron Spectros. Rel. Phenom. **88-91**, 1015 (1998).