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4D Equivalence Theorem and Gauge Symmetry on an Orbifold, Yoshikazu Abe, Naoyuki Haba, Katsuhiro Hayakawa, Yasunori Matsumoto, Mamoru Matsunaga and Kenta Miyachi1: Prog Theor. Phys., 113, pp.199-213, 2005.

We investigate high-energy behavior of the scattering amplitudes in extra dimensional gauge theory where the gauge symmetry is broken by the boundary conditions. We study, in particular, the 5D $SU(5)$ grand unified theory whose 5th-dimensional coordinate is compactified on S^1/Z_2. We pay attention to the gauge symmetry compatible with the boundary conditions on an orbifold and present the BRST formalism of the 4D theory that is obtained through integration of the 5D theory along the extra dimension. We derive the 4D equivalence theorem on the basis of the Slavnov-Taylor identities. We also calculate the amplitudes of the process including four massive gauge bosons in the external lines and compare them with those for the connected reactions in which the gauge fields are replaced by the corresponding would-be Nambu-Goldstone (NG) fields. We explicitly confirm that the equivalence theorem holds.

Influences of Homeotropic Anchoring Walls upon Nematic and Smectic Orderings, Masashi Torikai and Mamoru Yamashita: J. Phys. Soc. Jpn., 74, pp. 955-959, 2005

McMillan liquid crystal model sandwiched between strong homeotropic anchoring walls is studied. Phase transitions between isotropic, nematic, and smectic A phases are investigated for wide ranges of an interaction parameter and of the system thickness. It is confirmed that the anchoring walls induce an increase in transition temperatures, dissappearance of phase transitions, and an appearance of non-spontaneous nematic phase. The similarity between influence of anchoring walls and that of external fields is discussed.

Change of Order of Nematic Phase Transition in Uniaxially Anchored Systems, Muniriding Yasen, Masashi Torikai and Mamoru Yamashita: Mol. Cryst. Liq. Cryst., 438, pp. 77-90, 2005

Nematic phase transition with both uniaxial and biaxial order parameters is studied in the two kinds of external fields which are conjugate to the order parameters, respectively. A global phase diagram on the fields versus temperature space is obtained in the mean field theory, which is similar topologically to the phase diagram of the three-state Potts model in three dimension. From this phase diagram, the phase diagram of the system in the uniaxial filed is derived, and the result is applied to the phase transition of the thin system anchored uniaxially, i.e., by the homeotropic and planer walls.

Similarity and dissimilarity between Influences of Anchoring Walls and External Fields on Nematic and Smectic A Phases, Masashi Torikai and Mamoru Yamashita: Mol. Cryst. Liq. Cryst., 441, pp. 59-67, 2005

The McMillan liquid crystalline models under the influence of homeotropic anchoring walls and of external fields are investigated. For thin systems, the existence of the critical thickness, below which the system does not undergo a discrete phase transition, is confirmed. Apparent differences between the influence of the anchoring walls and of external fields are elucidated by investigating the order parameters and a temperature vs external field phase diagram for the bulk systems.

Biaxial Field and Crossover between Homeotropic and Homogeneous Structures in the System Anchored by Biaxial Walls, Masaki Ito, Masashi Torikai and Mamoru Yamashita: Mol. Cryst. Liq. Cryst., 441, pp. 69-85, 2005

Landau free energy with both of uniaxial and biaxial order parameters is derived in the framework of Maier-Saupe model, based on which a phase diagram in two types of external fields is obtained. The free energy is generalised to be applied to the thin system sandwiched by parallel boundary walls of biaxial anchoring, and nematic ordering occurring therein is studied, where the biaxiality is introduced by the fixed orientation of molecules on the boundary walls. The first order phase transition becomes critical behaviour at a critical thickness, and the system thinner than this has no transition as the case of homeotropic structure, and biaxiality dependence of the critical thickness is evaluated. A crossover between homeotropic and homogeneous structures is shown to occur at a certain biaxial condition, where the first order transition changes to the second order one as the thickness decreases.

MD Simulation of Bent Gay-Berne Molecule Systems; Molecular Shape and Flexibility, Toshikuni Miyazaki* and Mamoru Yamashita: Mol. Cryst. Liq. Cryst., 441, pp. 329-338, 2005

Molecular dynamics simulation is carried out at the system of bent molecules to study the effects of a molecular bend and flexibility to the liquid crystalline ordering. The molecule is a dimer of two types of Gay-Berne particles connected by a harmonic spring at each ends and makes a given angle in the energy minimum at an isolated state. A decrease of clearing temperature with an increase of the bend angle is depicted. By changing a strength of the spring constant, an influence of flexibility to the ordering is studied, where the clearing temperature shows a sigmoidal curve for the spring constant and the nematic ordering is hardly observed in the soft limit. To see the another effect of molecular shape to the ordering, two types of different combinations of length of the constituent Gay-Berne particles are introduced and ordering behaviours are tested.

Superconductivity in the CuO Double Chain of $Pr_2Ba_4Cu_7O_{15-\delta}$ on the basis of Tomonaga-Luttinger Liquid Theory, Kazuhiro SANO, Yosiaki ONO*, Yuh YAMADA*: J. Phys. Soc. Jpn. 74, pp. 2885-2888

Recently, Matsukawa *et al.* discovered a new superconductor, $Pr_2Ba_4Cu_7O_{15-\delta}$, in which metallic CuO double chains are responsible for the superconductivity. To investigate its superconductivity, we employ the d-p double chain model where the tight-binding parameters are determined so as to fit a band structure in the local density approximation (LDA). On the basis of the Tomonaga-Luttinger liquid theory, we obtain a phase diagram that includes the superconducting phase in the weak coupling limit. We also calculate the Luttinger liquid parameter K_ρ as a function of the electron density n using the Hartree-Fock approximation. With increasing n from quarter filling, K_ρ increases and then exceeds 1/2 when the superconducting correlation becomes most dominant. K_ρ has a maximum at an optimal density between quarter- and half-filling. These results are consistent with the experimental observation.

An empirical potential approach to structural stability of GaN_xAs_{1-x} thin films on GaAs(111), Tomonori ITO, Takashi SUDA, Toru AKIYAMA, Kohji NAKAMURA : Applied Surface Science 244, pp. 170-173, 2005.

Structural stability of GaN_xAs_{1-x} thin films coherently grown on GaAs(111) is systematically investigated based on an empirical potential, which incorporates electrostatic energies due to bond charges and ionic charges. Using the empirical potential, the system energies of zinc blende (ZB) and wurtzite (W) structured GaN_xAs_{1-x} thin films are calculated over the entire concentration range. The calculations for interface structures between ZB- or W-GaN_xAs_{1-x} thin films and GaAs(111) substrate reveal that ZB-type stacking sequence is more favorable than W-type stacking sequence at the interface. Consequently, ZB-GaN_xAs_{1-x} thin films can be fabricated in the concentration range of $x<0.5$ on the GaAs(111), whereas W-GaN_xAs_{1-x} thin films are formed with ZB-type stacking interface in the concentration range of $x\geq0.5$.

An ab initio-based approach to Ga adatom migration on GaAs(n11)A-(001) non-planar surfaces, Tomonori ITO, Koichi ASANO, Toru AKIYAMA, Kohji NAKAMURA, Kenji SHIRAISHI*, Akihito TAGUCHI* : Applied Surface Science 244, pp. 178-181, 2005.

The behavior of Ga adatoms on GaAs(n11)A (n=2, 3, 4), (001)-(2x4)β2 and non-planar surfaces consisting of the (211)A and (001) are systematically investigated by ab initio–based approach and the Monte Carlo (MC) method. The ab initio total energy calculations clarify strong dependence of Ga adsorption energies on the surface index, where adsorption energies of Ga on the (211)A and (311)A are larger by 1.0~1.4 eV than those on (001) and (411)A. Furthermore, the MC simulations reveal that diffusion coefficient of Ga adatoms across the (001) surface is larger than that on the (211)A surface. This is because Ga migration potential energies on the (001) surface are smaller than those on the (211)A surface. Reflecting these results, Ga adatoms on the (211)A-(001) non-planar surface migrate on the (211)A side surface beyond ~1100 K, whereas Ga adatoms mainly diffuse across the (001) surface below ~1100 K.

An empirical potential approach to dislocation formation and structural stability in GaN_xAs_{1-x}, Keiichi KAWAMOTO, Takashi SUDA, Toru AKIYAMA, Kohji NAKAMURA, Tomonori ITO : Applied Surface Science 244, pp. 182-185, 2005.

We study the feasibility of our empirical potential to dislocation formation and its contribution to the structural stability in GaN_xAs_{1-x}. The feasibility of our empirical potential to dislocation formation is exemplified by the calculation of dislocation core energy and core radius for various dislocation core structures in wurtzite structured GaN such as those described by eight coordinated channels, four coordinated channels and five- and seven-coordinated channels (5/7 core). The calculated results imply that the most stable core structure in the GaN is the 5/7 core structure. Moreover, GaN_xAs_{1-x} changed its structure from zinc blend to wurtzite at the concentration of x_c=0.3 with dislocation and x_c=0.4 without dislocation. This is because 5/7 dislocation core favors the wurtzite structured GaN_xAs_{1-x} with lower core energy than that in zinc blend structured GaN_xAs_{1-x}.

Theoretical investigation of phase transition on GaAs(001)-c(4×4) surface, Hirotoshi ISHIZAKI, Toru AKIYAMA, Kohji NAKAMURA, Kenji SHIRAISHI*, Akihito TAGUCHI*, Tomonori ITO : Applied Surface Science 244, pp. 186-189, 2005.

Surface phase transition between GaAs(001)-c(4×4) and -(2×4)β2 surfaces is systematically investigated by using our ab initio-based approach. The phase diagram of the c(4×4) surfaces is clarified as functions of temperature and As pressure, when the c(4×4) periodicity is kept. The phase diagram calculations reveal that three kinds of c(4×4) surfaces consisting of Ga-As dimers and/or Ga-Ga dimers become stable near the phase transition temperature. Based on this finding, the electron counting Monte Carlo simulation and ab initio pseudopotential calculations are performed to investigate the structural change of the c(4×4) surface after predepositing a 0.5 monolayer of Ga on the three kinds of c(4×4) surfaces found near the phase transition temperature. The calculated results suggest that the c(4×4) surfaces possibly change their structures to (2×4)β2 structures with Ga-As surface dimers.

Magnetic domain wall structures in free-standing Fe(110) monolayers, Yoshifumi TAKEDA, Kohji NAKAMURA, Toru AKIYAMA, Tomonori ITO : Applied Surface Science 244, pp. 485-488, 2005.

We performed first principles calculations for magnetic domain wall structures in free-standing Fe monolayers with lattice constants matching with those of bcc Fe(110) and W(110) substrates by using the FLAPW method that incorporates intra-atomic noncollinear magnetism. The self-consistent calculations predict atomically narrow domain walls with widths of about 8 and 14 Å for the monolayers with the lattice constants of the Fe and W, respectively. These results are qualitatively consistent with and support domain walls having a 6 Å width in the Fe monolayers on a W(110) substrate recently observed in spin-polarized scanning tunneling microscopy experiments.

Role of exchange interaction and spin-orbit coupling in magnetic domain walls in bulk and thin film Fe. Kohji NAKAMURA, Tomonori ITO, A. J. Freeman* : Journal of Applied Physics 97, pp. 10A315-1-10A315-3, 2005.

We investigate magnetic domain wall structures in bulk Fe and a thin film Fe(110) monolayer with the first principles full-potential linearized augmented plane-wave method including intra-atomic noncollinear magnetism. In the bulk case, the exchange interaction favors the slower variation of the magnetization and the wall width is determined by a competition between the exchange interaction and the magnetic anisotropy arising from the spin-orbit coupling (SOC)-as expected from phenomenological theory. In the thin film, however, the magnetization in the domain wall changes rapidly within a width of 8 Å. This narrow domain wall arises from the exchange interaction while the SOC favors the ferromagnetic state. Importantly, we find that the SOC effects give rise to not only the magnetic anisotropy but also to a breaking of the degeneracy of the Bloch and Néel walls, which plays a minor role in the bulk but a major role in the thin film.

Microscopic theory of oxygen reaction mechanism at SiO_2/Si(100) interface, Toru AKIYAMA, Hiroyuki KAGESHIMA*, Tomonori ITO : Proceedings of the 27th International Conference on the Physics of Semiconductors, pp. 393-394, 2005.

Microscopic mechanisms of reaction of oxygen at SiO_2/Si(100) interface are studied based on first-principles calculations. It is found that in the SiO_2 region of the interface the most stable configuration of reaction species is molecular-type oxygen which does not form any bonds with SiO_2-network forming atoms, while the O_2 in the Si substrate dissociates and forms two Si-O-Si bonds. The calculated energies indicate that the incorporation of O_2 molecules into the Si substrate dominates the interfacial reaction of the oxidant. The cooperative reaction of each O atom of the O_2 with each Si atoms at the interface leads to the low energy barrier compared with that of the O atom.

First-principles study of excess Si-atom stability around Si-oxide/Si interfaces, Hiroyuki KAGESHIMA*, Masashi UEMATSU*, Kazuto AKAGI*, Shinji TSUNEYUKI*, Toru AKIYAMA, Kenji SHIRAISHI : Proceedings of the 27th International Conference on the Physics of Semiconductors, pp. 389-390, 2005.

The stability of excess Si around the Si-oxide/Si interfaces is studied using the first-principles calculation. The excess Si is suggested to flow into the oxide from the substrate. The excess Si flowing into the oxide becomes SiO interstitials with the O-vacancy-like structure, which can be one of the sources of the E'-centers or the charge traps in the oxide. This Si flow is expected to be rather easier because SiO interstitials can be created via a simple rebonding procedure in the oxide.

Half-metallic ferrimagnetism in zinc blende Mn-doped transition metal chalcogenides, Kohji NAKAMURA, Tomonori ITO, A. J. Freeman* : Physical Review B 72, pp. 064449-1-064449-6, 2005

First principles full-potential linearized augmented plane wave (FLAPW) calculations and Monte Carlo simulations were performed to determine the magnetic structure in Mn-doped transition metal chalcogenides, $Cr_{1-x}Mn_xSe$ and $Cr_{1-x}Mn_xTe$, with the zinc blende structure. A ferrimagnetic structure with excellent half-metallicity appears in the Mn 0.25 composition, where the Mn moments tend to align in an opposite orientation to the Cr moments so as to retain the half-metallicity, and the half-metallic gap is enhanced. Here, the $Cr_{0.75}Mn_{0.25}Se$ alloy is is predicted as a promising candidate as a high Curie temperature half-metallic ferrimagnet, with the tendency toward an atomic ordering of Cr and Mn atoms, that may be feasible in epitaxial growth that is thick enough for spintronic applications.

Theoretical investigation of oxygen diffusion in compressively strained high-density α-quartz, Toru AKIYAMA, Hiroyuki KAGESHIMA*, Masashi UEMATSU*, Tomonori ITO : Japanese Journal of Applied Physics 44, pp. 7427-7429, 2005.

The microscopic mechanisms of oxygen diffusion in compressively strained high-density α-quartz are investigated on the basis of first-principles total-energy calculations. It is found that both the incorporation energy of oxygen into SiO_2 and the energy barrier for its diffusion are dependent on the density of SiO_2. The activation energies show that molecular-type oxygen is the dominant diffusion species over the entire density range. Furthermore, the activation volumes estimated from the results of the present first-principles calculations imply that the retardation of oxygen diffusion in the high-density region.

An ab initio-based approach to phase diagram calculations for GaAs(001) surfaces, Tomonori ITO, Hirotoshi ISHIZAKI, Toru AKIYAMA, Kohji NAKAMURA, Kenji SHIRAISHI*, Akihito TAGUCHI* : e-Journal of Surface Science and Nanotechnology 3, pp. 488-491, 2005.

Surface phase diagram of GaAs(001) is systematically investigated by using our ab initio-based approach. The phase diagrams of the c(4×4) and (2×4) surfaces are clarified as functions of temperature and As pressure. The calculated results reveal that c(4×4)β and (2×4)γ surfaces are strongly affected by As-molecular species such as As_2 and As_4. The c(4×4)β surface consisting of As dimers disappear under As_4because of small desorption energy of As dimers. The (2×4)γ surface appears only at high As pressure and low temperatures buried in the stable region of c(4×4)β under As_4. These results are compared with experimental results to check the versatility of our approach to the surface phase diagram calculations.

Theoretical investigation of indium surface segregation in InGaN thin films, Shingo INAHAMA, Toru AKIYAMA, Kohji NAKAMURA, Tomonori ITO : e-Journal of Surface Science and Nanotechnology 3, pp. 503-506, 2005.

Surface segregation of In atoms in InGaN thin films on GaN(0001) substrate is investigated by using Monte Carlo simulations based on an empirical potential, which incorporates electrostatic energy due to bond charges and ionic charges. The calculated In composition of the surface monolayer (ML) x_s in $In_{0.1}Ga_{0.9}N$ thin films ranging from 1 to 31 ML predicts that In atoms segregate at the topmost layer even in the film thickness t being larger than 3ML. The x_s at the topmost layer saturates when t reaches ~15 ML, in which x_s is much larger (x_s ~0.7) than the normal alloy composition (x~0.1). Furthermore, analysis of x_s with respect to the bulk composition x up to 0.2 reveals that the propensity of In atoms for being segregated at the surface corresponds to the bond energy difference between InN and GaN. These calculated results imply that not only the release of elastic strains due to lattice mismatch between InN and GaN but also the presence of Ga-N bonds over In-N bonds in the bulk region contributes the segregation of In atoms at the surface in InGaN thin films.

Theoretical investigation of the structural stability of zinc blende GaN thin films, Tatsuya ARAKI, Toru AKIYAMA, Kohji NAKAMURA, Tomonori ITO : e-Journal of Surface Science and Nanotechnology 3, pp. 507-510, 2005.

The structural stability of zinc blende (ZB) structured GaN thin films on ZB-GaN(001) and ZB-SiC(001) substrates is systematically investigated based on an empirical potential, which incorporates electrostatic energy due to covalen bond charges and ionic charges. The calculated energy difference between pure ZB-GaN and mixed structure of wurtzite (W) and ZB-GaN (ZB-W-GaN) on ZB-GaN(001) implies that ZB-GaN is stabilized up to the film thickness of 554 ML. Furthermore, similar calculations incorporating misfit dislocations (MDs) on ZB-SiC(001) show that ZB-GaN pseudomorphically grown on ZB-SiC(001) initially changes its structure to ZB-GaN with MD at 28 ML in good accordance with cirtical thickness of misfit dislocation generation of 32 ML estimated by People-Bean formula. The ZB-GaN with MD is successively transformed into ZB-GaN with MDs at 294 ML and finally ZB-W-GaN at 865 ML. These results suggest that MD generation crucially affects the stability of ZB-GaN.

Reaction mechanisms of oxygen at SiO_2/Si(100) interface, Toru AKIYAMA, Hiroyuki KAGESHIMA* : Surface Science 576, pp. 65-70, 2005.

First-principles total-energy calculations are performed to clarify the reaction mechanisms of O atoms and O_2 molecules at SiO_2/Si(100) interface. The calculated energies reveal that the incorporation of O_2 molecules into the substrate dominates the interfacial reaction of the oxidant. The low energy barrier for O_2 incorporation (0.2 eV) corresponds to the hybridization of oxygen-2p orbitals of O_2 and the valence band states of the Si substrate, while that for O atom incorporation corresponds to the O-O bond dissociation and the formation of Si-O-Si bonds. The cooperative reaction of each O atom in the O_2 molecule with each Si atom at the interface leads to the low energy barrier.

Fabrication of Compensation System for 2nd Order Chromatic-Dispersion Distortion in Lightwave CATV Transmission Systems, Takashi TAKEO, Tomohiko TANIE*: The Transactions of The IEICE, Vol.J88-C, 574-575, 2005

Compensation system for 2nd order chromatic-dispersion in lightwave CATV transmission systems has been proposed. The system utilizes a push-pull transmission scheme and consists of two identical optical transmission lines. Two RF signals whose phases are inverted each other through a push-pull transformer are input into two laser diodes, and after an optical transmission through optical fibers these signals are combined again through another push-pull transformer to obtain the undistorted signals. Improvements of about 15dB in the 2nd order distortion were obtained with the present system.

Synchronous Averaging for Asynchronouse Sampling Data, Yuichi Noro and Kazuhiro Kuno: T.IEE Japan, 125-C, 12, pp. 955-959, 2005.

The progress of digital audio technology enabled the familiar use of the products such as CD and DAT in the acoustic measurement. For example, a signal reproduced with CD player is inputted into a subject of measurement and DAT recorder records its response. However, the sampling cannot be synchronized completely with the input signal although both nominal sample rates are set up equally, because player and recorder work independently. It is the most popular software solution to perform the synchronous addition after converting the recorded signal into the original sampling rate. However, the rate conversion also has the error due to the windowing in the high frequency region of processed signal. This paper proposes a new method for averaging asynchronous sampling data to solve these problems.

Damping Parameter and Wall Velocity of RE-TM Films, Tadashi KOBAYASHI, Hideaki HAYASHI, Yuji FUJIWARA, Shigeru SHIOMI: IEEE Trans. Magn., 41, pp.2848-2850, 2005.

The temperature dependence of the Gilbert damping parameter and domain wall velocity of ferrimagnetic rare earth-3d transition metal alloy (RE-TM) films are discussed. The Gilbert damping parameter is assumed to be inversely proportional to the net angular momentum of the RE-TM. Under this assumption, wall velocity is simulated. In the case of wall motion utilizing the temperature gradient of wall energy, the wall velocity reaches a maximum in the vicinity of the angular momentum compensation temperature of the RE-TM.

Exchange-Coupling in Magneto-optical Recording, Tadashi KOBAYASHI, Yuji FUJIWARA, Shigeru SHIOMI: J. Magn. Soc. Jpn., 29, pp.1027-1034, 2005.

Exchange-coupling in magneto-optical recording is reviewed. Exchange-coupling has been widely used for improving the *S/N* ratio of the readout signal, overwriting by light intensity modulation or readout of tiny marks, and other purposes. Although the strength of the exchange-coupling is characterized using the interface wall energy σ_w or the exchange-coupling energy *J*, σ_w and *J* should be distinguished. A relatively large value of σ_w can be easily obtained, using a conventional sputtering apparatus. Exchange-coupling in rare earth-3d transition metal films and methods of controlling it are summarized. The value of σ_w can be reduced by inserting an intermediate layer. Control of the temperature dependence of σ_w is somewhat difficult. In the case of switching of the exchange-coupling, the thickness as well as Curie temperature of the switching layer is an important parameter.

High-Pressure Viscosity Measurements of Traction Oils up to 2 GPa at up to 200 ℃ [in Japanese], Yuichi NAKAMURA, Kazuyuki SANDA* and Hideki MATSUBO*: Journal of Japan Society of Tribologists, 50-4 pp. 354-359, 2005

High-pressure viscosity was measured for synthetic traction oils including a CVT oil up to 2 GPa at elevated temperature up to 200 ℃ employing a falling sphere method in a diamond-anvil pressure cell (DAC) with appropriate heating system. The obtained results almost showed the linearity between logarithmic viscosity and pressure at all temperature (40℃～200℃) with some data scattering. The accuracy of this high pressure viscometry was confirmed with the existing data at low pressure. Viscosity-pressure coefficient α decreased to 1/3～1/4 at 200℃ of that at 40℃. Simple experimental expression of temperature depending α was suggested referring to Eyring viscosity formula. Pressure temperature phase diagrams of liquid-solid transition were plotted from the obtained high pressure viscosity, which predict traction feature.

Micro-Rheometry of Pressurized Lubricants and Micro-Nanorheology, Yuichi NAKAMURA, Yasushi KUROSAKI: Microsystem Technologies, Special Issue: JSME-IIP/ASME-ISPS Joint Conference 2003 Yokohama, 11, pp. 1127-1131, 2005

In the present study, micro-rheometry of pressurized lubricants employing a diamond-anvil pressure cell and a laser confocal displacement sensor of 0.4μm resolution was shown. High pressure viscosity was obtained up to 2 GPa at 200 ℃ for traction oils and PFPE oils. Viscosity-pressure coefficient α at room temperature was almost twice larger than that at 100 ℃. α for hard disk oil, Zdol2000, was 13 /GPa at 24 ℃ ～ 5 /GPa at 150 ℃ and was similar to that of paraffinic mineral oil. The feature of the obtained high pressure volume was different for each oil up to 6 GPa. Zdol2000 was the most compressible of all the sample lubricants and its high pressure refractive index increased about 10 % at 4.8 GPa. Zdol2000 remained transparent up to 4.8 GPa under isothermal loading. Some considerations for lubricant's micro-nanorheology were also mentioned with high pressure lubricant's rheology.

Evaluation of Quasi-Static Density and Elastic Modulus for Pressurized Lubricant Oils up to 5 GPa Considering Volume Viscoelasticity, Yuichi NAKAMURA, Yasushi KUROSAKI and Nobuyoshi OHNO*: Book of Synopses International Tribology Conference Kobe 2005, pp. 171, 2005

Quasi-static pressure-dependence equations of density and elastic modulus for lubricant oils were derived up to 5 GPa based on the experimental data from both quasi-static pressure vessel apparatus up to 1.2 GPa and dynamic sound velocity data by Brillouin light scattering measurements up to 5 GPa. Dynamic data were analyzed by applying a viscoelastic model for volume change and quasi-static data were obtained. Examined lubricant oils were 3 naphthenic oils such as traction oils, 5P4E (five-ring polyphenyl ether) and DOS (dioctylsebacate). Lubricant oils whose solidified pressure is lower than 1 GPa were resulted to show almost the same pressure-dependence characteristics of density and bulk modulus over solidified pressure. Temperature-dependence of these equations found out to be small up to 155 ℃.

Plastic Deformations of Micro-spheres by Solidified Lubricants and Lubricants' Shear Stress under Very High Pressure, Yuichi NAKAMURA, Masanori SHIMAOKA, Yutaka ISHIBASHI* and Masahito MATSUI: Proceedings of WTC2005 World Triborogy congress III, CD, 63099, 2005

In order to grasp the possibility of evaluating shear properties for solidified lubricants under high pressure, plastic deformations of metal micro-spheres (about 0.07mm) in solidified lubricants were evaluated by employing a diamond- anvil pressure cell (DAC). Large deformations (2-5 times larger than the original sphere dimensions) were observed for CVT oil and ester oil up to 6 GPa at

23-25℃. Deformation starting pressure agreed with the solidified pressure. These deformations were caused by the non-hydrostatic pressure in the solidified lubricants. Shear stresses of the solidified lubricants were tentatively and roughly estimated from the plastic deformations of the spheres based on some assumptions. They almost agreed with the mean shear stress (traction force / hertzian contact area) from traction test.

High-Pressure Viscometry and Dilatometry for Lubricant Oils in a Diamond Anvil Cell Up to 6 GPa, Yuichi NAKAMURA, Kazuyuki SANDA* and Hideki MATSUBO*: Proceedings of WTC2005 World Triborogy congress III, CD, 63100, 2005

To measure the properties of lubricant under high pressure, a diamond–anvil pressure cell was employed. With a falling sphere viscometry, viscosities were measured up to 2 GPa at up to 200 ℃ for traction oils. The results showed linearity between logarithmic viscosity and pressure at any temperatures. At 200℃, lubricant viscosity-pressure coefficient fell to between 1/4 and 1/3rd of the value at 40℃. A simple expression for the dependence of high pressure viscosity on temperature has been suggested. Pressure temperature phase diagram of liquid-solid transition was plotted from the obtained viscosity. The change in volume due to solidification was estimated up to 6 GPa.