Finite-size effects in fine particles: magnetic and transport properties.

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Integrated genetic analysis microsystems

Eric T Lagally and Richard A Mathies

2004 *J. Phys. D: Appl. Phys.* **37** R245

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With the completion of the Human Genome Project and the ongoing DNA sequencing of the genomes of other animals, bacteria, plants and others, a wealth of new information about the genetic composition of organisms has become available. However, as the demand for sequence information grows, so does the workload required both to generate this sequence and to use it for targeted genetic analysis. Microfabricated genetic analysis systems are well poised to assist in the collection and use of these data through increased analysis speed, lower analysis cost and higher parallelism leading to increased assay throughput. In addition, such integrated microsystems may point the way to targeted genetic experiments on single cells and in other areas that are otherwise very difficult. Concomitant with these advantages, such systems, when fully integrated, should be capable of forming portable systems for high-speed *in situ* analyses, enabling a new standard in disciplines such as clinical chemistry, forensics, biowarfare detection and epidemiology. This review will discuss the various technologies available for genetic analysis on the microscale, and efforts to integrate them to form fully functional robust analysis devices.

https://doi.org/10.1088/0022-3727/37/23/R01 Cited by References

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Magnetic materials for MEMS applications

M R J Gibbs, E W Hill and P J Wright

2004 *J. Phys. D: Appl. Phys.* **37** R237

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This topical review discusses magnetic microelectromechanical systems (MagMEMS). A number of exemplars are drawn from the authors' own work, and a review is given of other significant literature in the area. The case is made that MagMEMS offer unique features over conventional MEMS, such as remote interrogation and self-test. A review of the key magnetic principles and magnetic materials is included by way of a guide to the general reader. Finally, a roadmap for the future development of MagMEMS is set out.

https://doi.org/10.1088/0022-3727/37/22/R01 Cited by References

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Plasma electron temperatures and electron energy distributions measured by trace rare gases optical emission spectroscopy

V M Donnelly

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This article reviews a spectroscopic method for extracting plasma electron temperatures and electron energy distributions: trace rare gases optical emission spectroscopy. Specifically, traces of Ne, Ar, Kr, and Xe are added to the plasma and the intensities of emissions from the Paschen 2p levels are recorded. Intensities are also computed from a model that includes direct excitation from the ground state, as well as two-step excitation through the $^3P_2$, and $^3P_0$ metastable levels. A Maxwellian electron energy distribution function (EEDF), described by an electron temperature (T_e), is assumed, and T_e is extracted from the best match between the observed and

calculated relative emission intensities. By choosing emission from specific sets of levels, the range of electron energies effective in exciting emission can be selected and various portions of the EEDF can be investigated. Accurate measurement of T_e depends critically on accurate cross sections for electron impact excitation, and hence a large portion of this article is devoted to a critical review of this subject. Improving on previous treatments, the model for computing emission intensities and electron temperatures includes a complete analysis of the complex excitation and de-excitation of the metastable levels. Previous measurements of T_e and EEDFs in chlorine and oxygen inductively coupled plasmas are re-evaluated with the current model. In general, the current version of the model yields similar results; specific differences are discussed.

https://doi.org/10.1088/0022-3727/37/19/R01 Cited by References

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Overview of high performance fibre-optic sensing

Clay K Kirkendall and Anthony Dandridge
2004 *J. Phys. D: Appl. Phys.* **37** R197

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An overview of fibre-optic interferometry based sensing is given, particularly as it applies to high-performance sensing applications. The operation of a fibre-optic interferometer as a sensor is reviewed. The sensitivity limitations of a fibre-optic sensor are derived, and the system impact of multiplexing many sensors together is explored. A review of the development of the fibre-optic acoustic transducer is presented, as well as system applications and future trends in fibre-optic interferometric sensing.

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Tailoring magnetism by light-ion irradiation

J Fassbender, D Ravelosona and Y Samson
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Owing to their reduced dimensions, the magnetic properties of ultrathin magnetic films and multilayers, e.g. magnetic anisotropies and exchange coupling, often depend strongly on the surface and interface structure. In addition, chemical composition, crystallinity, grain sizes and their distribution govern the magnetic

behaviour. All these structural properties can be modified by light-ion irradiation in an energy range of 5–150 keV due to the energy loss of the ions in the solid along their trajectory. Consequently the magnetic properties can be tailored by ion irradiation. Similar effects can also be observed using Ga^{+} ion irradiation, which is the common ion source in focused ion beam lithography.

Examples of ion-induced modifications of magnetic anisotropies and exchange coupling are presented. This review is limited to radiation-induced structural changes giving rise to a modification of magnetic parameters. Ion implantation is discussed only in special cases.

Due to the local nature of the interaction, magnetic patterning without affecting the surface topography becomes feasible, which may be of interest in applications. The main patterning technique is homogeneous ion irradiation through masks. Focused ion beam and ion projection lithography are usually only relevant for larger ion masses. The creation of magnetic feature sizes below 50 nm is shown. In contrast to topographic nanostructures the surrounding area of these nanostructures can be left ferromagnetic, leading to new phenomena at their mutual interface.

Most of the material systems discussed here are important for technological applications. The main areas are magnetic data storage applications, such as hard magnetic media with a large perpendicular magnetic anisotropy or patterned media with an improved signal to noise ratio and magnetic sensor elements. It will be shown that light-ion irradiation has many advantages in the design of new material properties and in the fabrication technology of actual devices.

https://doi.org/10.1088/0022-3727/37/16/R01 Cited by References

Nanoprobing of semiconductor heterointerfaces: quantum dots, alloys and diffusion

R S Goldman

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Interfaces play a key role in the performance of electronic, optoelectronic and photovoltaic devices. Within epitaxial semiconductor heterostructures, interfaces are commonly characterized using various methods including transmission electron microscopy, secondary ion mass spectroscopy, x-ray diffraction, photoluminescence spectroscopy and capacitance–voltage profiling. The averaging present in these conventional techniques limits their ability to resolve critical atomic-scale features. In

addition, many of these methods require detailed modelling in order to determine quantitative interface profiles. Thus, these techniques are often not suitable for obtaining the localized information needed to elucidate the structure and properties of heterointerfaces. Alternatively, nanoprobing of heterointerfaces using cross-sectional scanning tunnelling microscopy (XSTM) has emerged as a powerful method for resolving atomic features at interfaces within heterostructures. In this paper, we describe XSTM and discuss its application to several important issues in semiconductor heterostructure materials, including the formation and ordering of quantum dot arrays, direct measurements of interdiffusion and segregation lengths and investigations of the mechanisms of alloy phase separation.

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Application of excitation cross sections to optical plasma diagnostics

John B Boffard, Chun C Lin and Charles A DeJoseph Jr

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Many optical-based plasma diagnostic techniques require electron-impact excitation cross sections. In recent years, a considerable number of new results have become available for excitation of rare-gas atoms from both the ground state and metastable states. Using relatively simple techniques these cross sections can be combined with plasma emission measurements to extract many useful plasma parameters such as the electron temperature. Many of the limitations of simple plasma emission models such as the corona model can be overcome by using cross section measurements to select what particular emission lines to use in the analysis.

https://doi.org/10.1088/0022-3727/37/12/R01 Cited by References

Recent progress in nanoimprint technology and its applications

L Jay Guo

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Nanoimprint is an emerging lithographic technology that promises high-throughput patterning of nanostructures. Based on the mechanical embossing principle, nanoimprint technique can achieve pattern resolutions beyond the limitations set by the light diffractions or beam scatterings in other conventional techniques. This article reviews the basic principles of nanoimprint technology and some of the recent progress in this field. It also explores a few alternative approaches that are related to nanoimprint as well as additive approaches for patterning polymer structures. Nanoimprint technology can not only create resist patterns as in lithography but can also imprint functional device structures in polymers. This property is exploited in several non-traditional microelectronic applications in the areas of photonics and biotechnology.

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Thermal and mechanical phenomena in micromechanical optics

Joseph J Talghader

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As the size of mechanical devices decreases and their power-handling specifications increase, thermal effects will become more and more important. This article is a basic survey of some of the most commonly seen thermal effects in micromechanical optics. The fundamental heat transfer mechanisms of conduction, convection, and radiation are quickly reviewed in regard to typical micromirror-type plates, and a simple measurement technique to extract thermal conductance is described. Interface thermal conductance is discussed in the light of recent experimental results on actuated micromechanical structures and squeeze-film theory. A new class of devices with tunable thermal conductance using controlled interface contact is discussed. Of particular interest are thermal IR detectors with extended dynamic range. Thermal expansion deformation is particularly detrimental to optics with two or more thin film layers. This is described in terms of an analytical elastic model, but the limitations of this are discussed in light of recent research. The model leads to a method for controlling thermal deformation, and micromirror devices are shown that are thermally invariant within $\lambda/60$ over at least 37°C. Finally, thermal fluctuation noise is described and shown to limit the finesse of high performance micromachined optical cavities and degrade the sensitivity of thermal nanomechanical detectors.

https://doi.org/10.1088/0022-3727/37/10/R01   Cited by   References

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Vertical-external-cavity semiconductor lasers

A C Tropper, H D Foreman, A Garnache, K G Wilcox and S H Hoogland

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Surface-emitting semiconductor lasers can make use of external cavities and optical pumping techniques to achieve a combination of high continuous-wave output power and near-diffraction-limited beam quality that is not matched by any other type of semiconductor source. The ready access to the laser mode that the external cavity provides has been exploited for applications such as intra-cavity frequency doubling and passive mode-locking. The purpose of this Topical Review is to outline the operating principles of these versatile lasers and summarize the capabilities of devices that have been demonstrated so far. Particular attention is paid to the generation of near-transform-limited sub-picosecond pulses in passively mode-locked surface-emitting lasers, which are potentially of interest as compact sources of ultrashort pulses at high average power that can be operated readily at repetition rates of many gigahertz.

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