International Adviser's Report for the Latest Progress by each Research Group of the HRC Project

Please complete this form on the results presented at 2nd International Symposium on the Manipulation of Advanced Smart Materials (ISMASM2008) and its Satellite Meeting

Please give your evaluation of each presentation on their results for its fundamental assumptions, methodology, findings, and academic implications of the conclusions. In addition, if necessary, please give your general comments on their preparation, presentation.

1. Group 1 (Lecture 6 at Satellite Meeting): "Deuterium NMR Study of Low Molar Mass Nematic Director Dynamics in a Confined Thin Film" by Akihiko Sugimura

One of the major activities of the Sugimura Group is the investigation of the static and dynamic behaviour of nematic films when subject to an electric field in the presence of the magnetic field of the NMR spectrometer. Such studies are of particular relevance to liquid crystal display technology. This piece of research has discovered the quite unusual behaviour of the director when the two fields are almost orthogonal. In static experiments for angles smaller than 90° the director is observed to be uniformly aligned by the composite action of the electric and magnetic fields. However, what is surprising is that as the angle between the fields approaches 90° the director adopts a non-uniform distribution. It is proposed that this non-uniformity is created by a variation in the electric field strength produced by a sinusoidal variation in the cell thickness caused by undulations of the electrode surface. Deuterium NMR spectra simulated using particular variations in the cell thickness appear to be in good agreement with this explanation. This is potentially an important result and it is essential that it receives experimental verification. This could be achieved by using electrodes formed from optically flat glass, employed in modern liquid crystal display technology, when the director non-uniformity should vanish. In addition, it would be valuable for the surface roughness to be explored using techniques such as atomic force microscopy. Finally, it would also be of some interest to explore theoretically how the field-induced director dynamics are influenced by the variation in the electric field strength.

2. Group 2 (INVITED Poster P-75 at ISMASM2008): "Demagnetizing factor of thin iron/nickel plate used for a solenoid induced helical wiggler" by Yoshiaki Tsunawaki, Nobuhisa Ohigashi, Mitsuhiro Kusaba, Makoto R. Asakawa

The overall aim of the Group lead by Professor Tsunawaki is the creation of a free electron maser which can then be used in the production of THz radiation, that is in the infrared region of the spectrum. This is an important and challenging ambition which is being undertaken with engineers at Kansai University. They intend to produce a compact system using a helical wiggler, so-called because it causes the electrons to deviate, side-to-side, from their velocity path when they pass through a region with a helical distribution of the magnetic field. One of the key requirements is that the electrons are injected into the wiggler through an adiabatic region in which the field strength grows to the maximum value of the wiggler; they then exit from the wiggler through the inverse adiabatic region. The creation of this adiabatic transition region using metal plates of varying sizes and shapes is proving to be problematic. The optimal design of the array of rectangular plates requires a theoretical based model. However, commercial packages appear to be unable to perform this task because of the finite size and rectangular shape of the plates. The problem has been successfully solved numerically but it is found that iron plates do not produce the desired profile inside the adiabatic region. However, several years ago it was recognized, by Professor Tsunawaki that this problem was associated with the high magnetic permeability of iron and that the solution was to employ nickel plates with its lower permeability to iron. The Group are to be congratulated on the creation both within the computer and the laboratory of the desired adiabatic transition sections for the wiggler.

3. Group 3 (Poster P-68 at ISMASM2008): “Ultrathin Al-doped transparent conducting zinc oxide films fabricated by pulsed laser deposition” by Masataka Nakamura, Ryota Michihata, Takanori Aoki, Akio Suzuki, Tatsuhiko Matsushita, Masahiro Okuda

The major aim of the Suzuki Group is to find a replacement for the indium-tin-oxide (ITO) thin films currently employed in a wide range of applications requiring transparent electrodes. These include flat panel liquid crystal displays and solar panels. The driving force for the replacement of ITO films is the decreasing availability of indium and its associated high cost. The challenge of finding an acceptable replacement depends on a variety of aspects, of particular significance is the creation of a material with a low resistivity (~10^{-5} Ωcm) which is stable in various environments and with the ability to be deposited on glass plates without loss of functionality. A number of groups are working on this important problem which makes its successful achievement even more challenging. Like the Suzuki Group they are also using zinc oxide doped with aluminium oxide (AZO). The key control parameter for this mixture is its composition although it is not clear to what extent this has been optimised and with respect to which of its properties. The AZO was deposited as a film on glass using pulsed laser deposition and this was formed in the desirable temperature range from 200°C to 300°C. Such films were then investigated using a range of techniques; the central quantity is the resistivity and this was found to be about $3x10^{-5}$ Ωcm which is somewhat high. The transparency is another important quantity and this seems to be acceptable. In addition, more fundamental quantities such as the atomic structure, determined by X-ray diffraction, and the surface structure, determined atomic force microscopy were investigated in detail. This is especially important if the practical behaviour of AZO films is to be understood. The laser deposition methodology seems promising especially if it can be used for large areas. In contrast the optimization of the AZO mixture composition and the introduction of other dopants seem to pose a special challenge, especially if the desired resistivity of the film and its stability are to be achieved.

4. Group 4 (Poster P-83 at ISMASM2008): “Development of the pattern drawing support tool in the wire netting work “by Akihiko Goto, Naoki Inoue, Makoto Kawasaka

The Group lead by Professor Goto has strong interests in the use of computer technology in design and the interaction of this with artisans. One example is concerned with the creation of wire nets employed in a range of artifacts such as a scoop for bean curd. These artifacts are cleverly constructed by twisting together a number of wires to form a network formed from a number of patterns such as hexagons. According to traditional methods the design of the wire net, that is the way in which the wires are twisted and bent, is achieved by a Master of the wire net in a cerebral manner. The Group has developed a computer based design tool which reconstructs the net resulting from a particular combination of wire manipulations. By varying parameters, such as twist length and bend angle, the resulting appearance can be readily constructed without having to depend on the skills and experience of a wire net Master. This is a considerable achievement but a number of questions need to be answered and explored. For example, does the computer design package reproduce all of the necessary skills of a Master or is there some essential aesthetic element missing? To answer such a question it would be valuable to work with a Master to evaluate the functionality offered by the design package. It would be of special significance to see if the design package might even enhance the products of a Master. It would also be of interest to see if the surface of the artifacts could be tessellated with shapes other than hexagons. A greater and possibly more valuable challenge would be to extend the design package to create objects with three dimensional surfaces as well as those in two dimensions.

Adviser’s signature and date
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