DAY ONE: Tuesday 13 March 2012

08.15 COFFEE AND REGISTRATION

09.00 Welcome and Introduction to Latex & Synthetic Polymer Dispersions 2012

Session 1: Naturally Occuring Latices – Properties and Applications

09.10 **Natural rubber latex industry – then and now**

Natural rubber latex (NRL) market is an important sub-set of the world rubber industry, accounting for over 12% of total natural rubber consumption in 2010. Concentrated on the dipping industry, especially the disposable gloves industry, the consumption of NRL has been growing above the rate of the underlying trend, increasing volume by 144% since 1988. This growth was accompanied by a shift in the geographical location of consumption, moving to North and Southeast Asia from Western Europe and North America. Asia now accounts for over 80% of total NRL consumption.

This relative success of the industry has attracted interests from the synthetic rubber world, centred on demand from the disposable gloves industry, which have intensified in the last five years. There is now around 500,000 tonnes (wet) of acrylonitrile butadiene rubber latex capacity in Southeast Asia, changing the landscape for the NRL.

No Dock Moung, International Rubber Study Group

09.40 **Biological and physical properties, and performance of latices from different botanical sources and effectiveness of some biobased fibers and fillers**

Many different plant species produce natural rubber but only a few of them have a suitable combination of yield, polymer molecular weight, rubber composition, and agronomic characteristics that renders them attractive as potential commercially-viable crops plants. These include the industrial giant *Hevea brasiliensis*, the latex of which can be modified in various ways post-tapping, and the temperature-zone species *Parthenium argentatum* and *Taraxacum kok-saghys*. The latices derived from these species, and others with more extreme characteristics, include the non-rubber components of the rubber particle monolayer biomembrane, of the latex serum and of the media used to stabilize the lattices during shipping and storage. The contribution of these components to the properties and performance of latex products will be discussed. Also, in support of our development of fully sustainable, biobased products,

preliminary tensiometric results will be presented on latex films incorporating a range of contrasting bio-based fillers and fibers prepared from agricultural and food processing wastes.

Prof Katrina Cornish, J Lauren Slutsky & Richard S Kamenik, The Ohio State University Ohio Agricultural Research and Development Center, USA

10.10 **New developments in the characterization of natural rubber latex**

Natural rubber latex is a material of great industrial interest, since more than 40000 products are manufactured with it. Nevertheless, the lack of characterization methods capable of analyzing quantitatively the crosslinking network structure of this elastomeric material is nowadays an important problem.

Currently, the most important methods used in both academia and industry to determine the crosslinking density of this material are: the number of chloroform, equilibrium swelling and determination of the relaxation modulus.

All these methods provide indirect information about some of the factors that determine the rubber network structure. In addition, they depend on important theoretical and experimental assumptions and simplifications, which cause significant uncertainties in the results.

In this sense, these methods need to break down the colloidal system that stabilizes the latex, to make coagulum or thin films in order to analyze the crosslink density. This fact provokes a succession of errors on the obtained result, due to structural changes on these samples by their manipulation.

These tedious experiments should be carried out by qualified personnel, because of the need of manipulating the sample. In addition, these experiments are very slow and they need the use of hazardous organic solvents, such as toluene or chloroform; which adds an environmental, economic and occupational health problem.

For these reasons, in this work we present a serial of methods that allow the complete characterization of the latex, throughout the industrial process; like measurement of TSC, DRC, prevulcanization (latex stage) and postvulcanization as well as the complete description of the elastomeric network structure (number of crosslinks, their spatial distribution and the content of network defects elastically inactive) avoiding the problems described above.

Justo Brasero & Dr J L Valentín, CSIC, Spain

10.40 Q & A SESSION

11.00 COFFEE AND NETWORKING

11.30 **Effect of natural starch on mechanical and biodegradation properties of natural rubber latex (NRL) films**

Natural Rubber Latex (NRL) were compounded with different types of natural starch with loading from 0 – 20 phr. The effects of post-processing (Aging, Leaching, and Biodegradation) on the films were investigated. Natural starch is used to facilitate the biodegradation process of the NRL films. Results shows that incorporation of natural starch in NRL films system decreased the films physical properties. As the starch loading increased, the physical properties become more severe. The post processing of NRL films (Leaching and aging) decrease the films physical properties and contribute to the reduction of extractable protein content of NRL films. Protein analyses validate the increasing of protein substances in NRL films with increased in natural starch loadings. SEM analysis confirmed the progress of NRL films degradation. Fourier Transform Infra-Red (FTIR) shows the breakage of doubly bonded carbon in control and films with natural starch films and the intensification of carbonyl group suggesting the formation of aldehyde and ketones group at week 4 of biodegradation periods together with biodegradation precursor for polyisoprene chain and starch molecular structure. Addition of natural starch in NRL films has shown positive results towards biodegradation process of NRL films.

M M Afiq & A R Azura, Universiti Sains Malaysia

12.00 **Effect of gamma radiation induced gel content of NR latex in quality improvement of radiation vulcanised natural rubber latex and high styrene content styrene butadiene copolymer latex blends**

Some of the factors that control the efficiency of vulcanisation of NR latex by gamma irradiation are initial molecular weight of rubber, green strength of rubber, the amount of non-rubber ingredients present and number of particles in NR latex. Generally latex concentrate is stored for about three weeks to achieve an improvement in molecular weight and hence green strength. In this work an attempt is made to improve gel content of fresh NR latex by exposure to low doses of gamma radiation followed by creaming of latex to reduce the non-rubber ingredients. The creamed latex is then vulcanised by exposure to gamma radiation in presence of n-butyl acrylate as sensitiser.

It is observed that on exposure of fresh NR latex to low doses of gamma radiation there is an increase in gel content favouring enhanced level of vulcanisation. Due to concentration of latex by a creaming process there is reduction in non-rubber ingredients that help in formation of coherent latex films. Unlike centrifugal process, the number of smaller rubber particles in latex after creaming is higher in creamed fraction. All these factors contribute to enhanced mechanical properties of Radiation Vulcanised Natural Rubber Latex (RVNRL).

It is observed that RVNRL could be more easily blended with synthetic latex because there is formation of graft copolymer and an enhancement in colloidal stability after irradiation. On blending RVNRL with high styrene content styrene butadiene copolymer latex (HSBL) the modulus increase depending on its concentration mainly due to the rigidity of rubber present.

RVNRL of improved mechanical properties are obtained by using creamed NR latex that has higher gel content and by blending RVNRL with HSBL.

Dr Rosamma Alex, I John Brito, Valsa George, Susamma Joseph, Benny George & Sadeesh Babu P S, Rubber Institute of India

12.30 Q & A SESSION

12.45 LUNCH AND NETWORKING

Session 2: Synthetic Latices – Properties and Preparation

14.00 **Latices from renewable sources - carbohydrates as multifunctional additives in emulsion polymerisation processes**

Classical synthetic latices mostly consist of petroleum-based components such as butadiene, styrene, acrylonitrile, acrylates and synthetic surfactants and initiators. A challenging field is the substitution of classical synthetic ingredients by natural based materials. Thus, carbohydrates as typical examples from renewable resources are predestinated for use in latex formulations. Due to their molecular structure they can be used in their native form as fillers and additives. Common procedures are e. g. blending of carbohydrates in their almost native form or to show higher compatibility in a slightly modified structure. Via chemical modifications, carbohydrates can be adapted to be used as polymerisable co-components in latex compositions. Special modified carbohydrates are used as excellent surfactant and stabilizer systems. By introducing thermo-labile functions that undergo a homolytic cleavage, carbohydrates can be used as surfactant-imitators in emulsion polymerization processes. This class of initiators gives special functions to the synthesized latices. In addition to the classical fields of applications in paper industry, dipping goods, coatings and adhesives, carbohydrate-modified latices can be used due to their multi-functionality in nano-technological applications. It is not only an ecological aspect for this substitution; also special tailored properties and application oriented profiles of the latices can be realized.

Dr Joachim Storsberg & Prof André Laschewsky, Fraunhofer IAP, Germany

14.30 **New developments in emulsion polymerization and synthetic latices**

Synthetic latices are important commercial feedstock used in a wide range of industries. Printing inks, coatings and paints, paper sizing, textiles and fibers are all manufactured from polymer latices which are synthesized from monomers derived from petroleum.

It is the main source from which synthetic rubbers such as styrene butadiene rubber are made. Very recently, synthetic latex such as acrylonitrile butadiene latex has also been used in making medical gloves for the healthcare industries. Most of the synthetic latices are prepared by emulsion polymerization and variation of this technique. High molecular weight latex particles and high rate of conversion can be achieved using this technique. A whole range of polymers and copolymers with different composition and properties can be synthesized by varying the monomer types and the

polymerization conditions used. Most of these polymer colloids contain polymeric latex particles of spherical shape that can be made to a precise size. Controlled structured non-spherical latex particles can also be tailored made. In more recent years new living radical polymerization techniques such as reversible addition-fragmentation chain transfer (RAFT) have open up considerable potential in incorporating chain architecture of the polymer molecule into the synthesis. This has allowed the preparation of a wide range of latex particles of block-copolymers, star-shaped polymers and gradient copolymers which are of great commercial values. In addition, various functional groups can be incorporated to the polymer chains at the latex particle surface by post-chemical modifications to serve specific purposes.

The applications of polymer colloids depend very much on the particle morphology, latex properties, the type and composition of the copolymer obtained and the molecular structure of the polymer synthesized. For paints and coating applications the latex particles must be soft and film forming. The coating formed must be hard and durable to protect the substrate underneath. For use as separation materials in chromatography, the particles must be hard and porous. For application as a barrier material such as medical gloves, the particles must be soft to form continuous film which is impervious to bacteria and viruses and the film thus formed must be soft yet strong and elastic for donning and for conforming to the contour of the hand. The synthesis of polymer colloids has now been extended to incorporate inorganic substances to create hybrid composite particles of various morphologies that possess diverse prospective applications. Some of these are within the nanosize range and falls in the realm of nanoscience.

This paper attempts to review recent advances made with respect to the polymerization technique in meeting the demanding diverse applications for synthetic latices.

Prof Chee C Ho, Universiti Tunku Abdul Rahman, Malaysia

15.00 **Accelerator free cross-linking of XNBR-Latex using UV techniques**

At present, the common used cross-linking process of XNBR-Latex on industrial scale is accelerated sulfur curing system with zinc oxide. To obtain the desired mechanical and donning properties of the latex goods, both covalent and ionic cross-links are required. Whereas the ionic links are generated due to a reaction of zinc ions with the carboxylic acid groups of the latex at higher pH values, the covalent bonds are achieved via the sulfur curing of the butadiene units. To avoid allergenic reactions related to residual accelerator levels in dipped XNBR-latex articles such as medical gloves a new curing process based on a photochemical reaction mechanism has been developed. The photochemical cross-linking is based on the thiol-ene addition reaction, and is carried out with a standard XNBR-latex without any pre-treatment. The reaction mechanism involves the excitation of a photoinitiator with UV light followed by a bond cleavage and the formation of free radicals. Due to the reaction with a poly-functional thiol component thiyl radicals are generated that are able to react with the C=C double bonds of the butadiene units under the formation of thioether links. On the one hand the photochemical cross-linking of the latex emulsion has been carried out in a falling film reactor and on the other hand solid XNBR-latex films have been cured via UV light. To generate ionic links in the rubber network thermal curing

with ZnO was carried out additionally. Our work has shown that the light intensity play an important role on the mechanical properties of the latex films such as tensile strength or elongation offering new ways to produce latex articles with tailored properties.

Dietmar Lenko & Sandra Schlögl, Polymer Competence Center Leoben GmbH; Raimund Schaller & Armin Holzner, Semperit Technische Produkte GmbH; Wolfgang Kern, Polymer Competence Center Leoben GmbH, University of Leoben, Institute of Chemistry of Polymeric Materials, Austria

15.30 Q & A SESSION

15.45 COFFEE AND NETWORKING

16.15 **A synthetic polyisoprene latex condom**

Male latex condoms are traditionally made from natural rubber latex and form the highest percentage of globally marketed condoms. Non natural rubber latex condoms are also available in the market and are typically made from polyurethane or themoplastic material. Synthetic polyisoprene latex condoms were recently introduced with Ansell SKYN® synthetic polyisoprene condoms being the first to be commercially available in the US, meeting stringent US FDA requirements.

This paper presents the properties of condoms made from synthetic polyisoprene latex. This includes features, tensile, burst inflation and ageing properties of condoms and films made from synthetic polyisoprene latex. User perception compared against polyurethane and natural rubber latex condoms will also be discussed.

Adeline Kung Ai Lin, Chintana Netrung, Sugath Amarasekera, David Lucas, Beng-Sim Chuah, Ansell, Malaysia

16.45 **Styrene-butadiene rubber latex polymers with improved auto-adhesion**

In the present environment there are incentives to identify a suitable replacement for natural rubber (NR) due to continually decreasing availability and increasing cost of natural products. Blending NR latex with small amounts of styrene-butadiene latex (SBR) has been practiced among adhesive formulators; sacrificing adhesive performance.

For some PSA applications NR has been a unique, hard to replace polymer among rubber based adhesives, due to its superior auto-adhesion characteristics, low tack and good compatibility with tackifiers. Newly engineered SBR latices potentially enable adhesive formulators to substantially substitute NR with SBR. Such latices offer improved auto-adhesion through molecular architecture and polymer characteristics.

In this paper we are discussing the design of new synthetic SBRs which can be blended in with NR at high concentrations without sacrificing adhesive performance. Examples are shown for application in cold seal adhesives.

Dr K Don Kim, Dr Tibor Pernecker & Tim Saddow, OMNOVA Solutions Inc, USA

17.15 Q & A SESSION

17.45 END OF DAY ONE

18.30 EVENING SOCIAL EVENT

DAY TWO: Wednesday 14 March 2012

08.00 COFFEE AND HOTEL CHECK-OUT

Session 3: Nanotechnology in Latex and Synthetic Polymer Dispersions

08.30 **Polymer latex nanocomposites: recent advances**

The field of polymer latex nanocomposites is stimulating both fundamental and applied research because these nanoscale materials often exhibit physical and chemical properties that are dramatically different form conventional microcomposites. A large number of nano particles, layers silicates, CNT and polymeric nanowhiskers are being used of the preparation of latex stage nano composites. Since the Toyota research group's pioneering work on nylon6/layered silicate nano composites, rubber latex nanocomposites containing nanofillers have attracted much attention. The latex nanocomposites can exhibit increased modulus, decreased thermal expansion coefficient, reduced gas permeability,increased solvent resistance and enhansed ionic conductivity when compared to the neat latex alone. In the proposed talk, the different preparation techniques for latex nanocomposites will be discussed. The role of various surfactants in improving the latex/filler interaction will be reviewed. The various characteristaion techniques for latex nanocomposites will be addresed. In the case of semi crystalline lattices the role of crystalisation on the the intercalation and exfoliation will be discussed. The dyanamic properties of latex nanocomposites such as Payne effect and Mullins effect will also be presented. Finally recent developments in the applications of latex nanocomposites will also be described.

Prof Dr Sabu Thomas, Mahatma Gandhi University Kottayam, India

09.00 **Nano-dispersions in latex technology**

Natural rubber latex being a nano-sized dispersion of rubber in aqueous medium, nano-dispersions of latex ingredients has got great importance in latex dipping industry. With the advancement of nanotechnology and rapid advances in new chemicals and milling process, “fine particle” technology has come within the reach of every industry. This is because the particle size of the chemical dispersions must be comparable to the size of the rubber particles (average size 580nm) in latex and capable of

mixing intimately. By matching the particle sizes the sedimentation in chemical dispersions during storage can be minimized. Lower chemical particle sizes are important for manufacture of thin walled articles like condoms, gloves, balloons etc. Moreover the zinc oxide stability of the latex and transparency of the products can be improved. The conventional chemical dispersions (micro-dispersions) are prepared using ball-mills whereas nano-dispersions are prepared from respective chemical preparation methods thereafter stabilization with suitable surfactants. In this paper, nano-ZnO has been synthesized and stabilized and its role in latex processing and technology was evaluated. Nano-dispersions are required in small quantities and are completely consumed in the system and the release to effluents are minimum. In the second phase, role of nano-filler dispersions (graphene and layered silicates) were evaluated in different latices. It has been found that polar latices like PU latex or CR latex has profound effect in nanocomposite properties when blended with NR latex.

Siby Varghese, Rubber Research Institute of India

09.30 **Effect of nanoclay on the properties of natural rubber (NR) and carboxylated styrene butadiene rubber (XSBR) latices: a comparison**

Nanocomposites of natural rubber (NR) and carboxylated styrene butadiene rubber (XSBR) latices of various filler loading have been prepared by latex stage method. Layered silicates and latex nanocomposites have been characterised by X-ray diffraction technique. The increased interlayer spacing observed in X-ray diffraction pattern indicated the intercalation of polymer chains into the layers of silicates. Properties such as mechanical, dynamic mechanical, gas transport and solvent uptake of unfilled and nano filled latex nanocomposites have been analysed as a function of filler loading. The mechanical properties are found to be increased owing to the better dispersion of nano filler in the polymer matrix and as a result the polymer/ filler interaction increases. Upon the addition of filler, the storage modulus of nanocomposites was found to increase due to the enhancement in stiffness of the material. Due to the restricted mobility of polymer chain segments the damping values decreased as a function of filler loading. An investigation of the viscoelastic properties revealed that there was a strong interaction between the polymer and the filler. The gas transport behaviour has been investigated with special reference to type of filler, gases, filler loading and pressure. The effect of free volume on the gas barrier properties has been investigated by positron annihilation lifetime spectroscopy (PALS). It is found that the relative fractional free volume of latex membranes decreased in the presence of layered silicates. It is observed that due to the platelet like morphology and high aspect ratio of layered silicates, the gas barrier properties of nano filled latex membranes are very high. The transport properties of aromatic solvents such as benzene, toluene and p-xylene through latex nanocomposite film have been investigated as a function of penetrant size, filler loading and temperature. Latex nanocomposites showed reduced swelling rate due to the tortuosity of the path and the reduced transport area in the polymeric membrane.

Ranimol Stephen, St. Joseph's College, & Sabu Thomas, Mahatma Gandhi University, India

10.00 Q & A SESSION

10.15 COFFEE AND NETWORKING

Session 4: Gloves

10.45 **World's first surgical glove with antimicrobial coating on inside surface**

Glove perforation during use is quite common, ranging from 12% for moderate abdominal procedures to more than 40% in more rigorous procedures such as orthopedic, trauma, and thoracic surgery. This proprietary powder-free antimicrobial surgical glove with the active ingredient, chlorhexidine gluconate, coated on the inside surface has been developed to give the user additional protection in case of glove breach during use by reducing the microbial load on the inside surface. The glove has a very thin layer of anti-stick overcoat covering the antimicrobial coating to prevent the glove from sticking. *In vitro* studies found that the glove killed >99% of an HCV surrogate virus, 99% of HIV-1 strain Mn as early as one minute following exposure. The glove was also found to reduce 99.7% to 99.999% of eight clinically relevant bacteria comprising gram-positive, gram-negative and drug-resistant bacteria over a 1-2 minute exposure in similar studies. In an in vivo study, the glove was found to remain active after two hours of wear time. Both real time and accelerated aging studies confirmed that the glove has at least two years of shelf life in meeting the EN455-4 requirements. The active ingredient was also found to remain stable and active during the shelf life studies.

Dr Eng Aik Hwee, Kuang Leng Lim, Lok Si Tang & David M Lucas, Ansell Shah Alam, Malaysia

11.15 **Polyurethane dispersion gloves applications: functional and eco-friendly**

Recently the disposable gloves industry is paying more and more attention to the advantage and benefit of PUD (polyurethane dispersions) gloves. PUDs being waterborne bring a whole change of green image to the glove industry. Polyurethane dispersion is made to meet the different requirements from the various markets for both medical and industrial applications.

Compared to the traditional materials used to make disposable gloves (Latex, PVC, Nitrile), PUDs offer a very simple formulation, easy process, and much cleaner gloves. PUD gloves are free from protein allergy, odour and powder.

PUDs being 1- component has no pot life which leads to material cost savings on the processing line. Cross-linkers, however ,like melamine and polyisocyanates can be added to further improve on the properties and higher chemical resistance requirements. Melamine is usually most preferred as it cures when subjected to curing temperature of 100 C and above and does not cause pot life issues which makes it ideal of continuous processing.

PUDs are exceptionally comfortable to wear, with good alcohol and chemical resistance. They can also be used in supported glove applications (a coating on a range of gloves made of cotton, nylon, etc.) to offer certain desired properties.

PUD-made gloves are much easier to dispose of without causing any harm to the environment as they are waterbased polymers and there are new potentials which can be made biodegradable. Further research work is being carried out currently. Any conversion of breaking down polymer has not shown any level of concerned toxicity so far. With stricter regulations on CMR (carcinogenic mutation and

reproductive) substances for medical and food applications, waterborne PUDs definitely serve as a solution for an alternative**.**

The dipping process enhances industrial gloves to be used in a wider dimension such oil or chemical barrier as protection, better skin sanitization properties , water-proofing , non-conductive properties and improvising tensile strength which makes them re-useable.

The next leap for PUD gloves manufacture is to venture into a breathable system which allows longer usage without buildup of sweat leading to skin irritation.

Rolf Irnich, ASEAN, China & Geetha Arumugam, ASEAN, Singapore

12.00 **A review of synthetic lattices in surgical glove use**

The majority of surgical gloves are still manufactured from natural rubber latex. However, in the race to reduce patient and medical staff allergy risks, a growing number of hospitals aim to eliminate products made from natural rubber, including surgical gloves. Examples of the alternative synthetic materials used today in surgical gloves include polychloroprene and polyisoprene.

However, replacement of natural rubber latex surgical gloves by synthetic alternatives has caused in the past some concerns regarding comfort and protection. Today, as high quality polyisoprene products are increasingly used in the healthcare world, such concerns are disappearing.

To further highlight and support this trend, we present a comparative study on commercially available surgical gloves made of various base materials. Mechanical properties evaluated include tensile strength, modulus, and puncture resistance. Based on the observations we infer that good quality polyisoprene surgical gloves offer mechanical protection comparable to NR gloves. Further, good quality polyisoprene surgical gloves are better than other synthetics in terms of comfort and equal, or even superior, to NR gloves.

Bert Krutzer, Marianne Ros, Joris Smit & Wouter de Jong, Kraton Innovation Center Amsterdam, The Netherlands

12.30 Q & A SESSION

12.45 LUNCH AND NETWORKING

Session 5: Standards and Regulations

14.00 **ISO 4047, the international standard for latex condoms, past, present and future**

The first edition of ISO 4074, the International Standard for Natural Rubber Latex Condoms, was published in 1990. Prior to the publication of this standard countries depended upon their own national standards for the regulation of condoms. This meant that condom manufacturers had to meet different requirements depending upon the countries to which the condoms were shipped.

Since its publication, ISO 4074 has become increasing important in regulating the approval and marketing of condoms around the world. The second edition of the standard, published in 2002, replaced EN 600 as the harmonized standard for latex condoms in Europe. Compliance with ISO 4074: 2002 is taken within Europe as evidence that the product complies with the essential requirements of the Medical Device Directive 93/42/EEC.

A new edition of ISO 4074 is now under development. This paper reviews the development of the standard since the first edition was published, the impact publication of the standard has had on the specification and testing of latex condoms, and the proposed changes to ISO 4074 that are expected to be included in the next edition of the standard when it published.

Dr William D Potter, Stapleford Scientific Service Limited, UK

14.30 **Regulatory requirements in the EU for latex products**

Satish Champaneri, BSI, UK

15.00 **Development of an ASTM standard for quantifying guayule proteins**

In 2008 the US Food and Drug Administration gave approval for the marketing of gloves made from GNR. Guayule Natural Rubber (GNR) was developed as an alternative source of latex in response to the advent of allergic reactions to Natural Rubber Latex. Even though protein levels of GNR are orders of magnitude lower than those found in Hevea, studies have shown that workers exposed to GNR have developed an immunological response to it. With the entrance of GNR products on the market the ASTM formed a Task Group and charged it with developing a standard to specifically quantify protein levels in GNR. This standard will serve manufacturers and suppliers who wish to monitor the quality of their supplies and products and will also be an aid in determining whether a product contains any latex derived from a natural source. The standard protocol is similar in design to that of the ASTM D6499. The results of the Task Group's studies show that the new standard has a lower detection limit than the D6499 and can be performed over a wide temperature range. Characteristics of the standard curve have also been determined and may be suggested as parameters for the proposed standard.

Dr David Kostyal, Dr Katrina Cornish & Kelly Horton, Akron Rubber Development Laboratory Inc, USA

15.30 Q & A SESSION

15.45 CLOSE OF PROCEEDINGS

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