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Contents Lists and Abstracts from the Journal of the Adhesion Society of Japan*

Journal of The Adhesion Society
of Japan, Vol. 36, No. 4 2000

CONTENTS

Original

- Analysis of Adsorption Force on Solid Surface with Micro
Tip – Influence of Surface Roughness, Surface
Energy and Adsorption Water Akira KAWAI [131]
The Effect of Acid Phosphate Compounds on Adhesion
Properties of Acrylic Adhesives Koichi TAGUCHI,
Toru INABA and Yutaka TAKEUCHI. [136]

Technical Report

- Thermomechanical and Adhesive Properties of
Copolyimides with Alcoxysilyl Group in the Polysiloxane
Segments . . . Nobuyuki FURUKAWA, Masatoshi YUASA and
Fumihiko OMORI [144]
Control of Catalytic Activity in Hydrosilylation Process
by Using Imine Derivatives . . . Katsuhiko KISHI, Taizo ISHI-
MARU, Masayoshi OZONO, Ikuyoshi TOMITA and Takeshi
ENDO [151]

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Nipponbashi, Naniwa-ku, Osaka 556, Japan.

Review

Adhesives in Living Hiroji NAGATA [157]

IV. Surface Modification

(4) Plasma Treatment Yu IRIYAMA [163]

Introduction of Laboratory Yasuo ARAI [170]

Analysis of Adsorption Force on Solid Surface with Micro Tip – Influence of Surface Roughness, Surface Energy and Adsorption Water

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(Accepted for publication : December 27, 1999)

The direct measurement of interaction force between two condensed matters is capable by using atomic force microscopy (AFM). However, an atomic flat surface can be obtained by cleavage of mica or graphite. Most of solid surfaces indicate micro roughness represented as square mean roughness R_{ms} . Moreover, in ordinal ambient condition, a certain moisture adsorbed on any solid surfaces and a meniscus between micro tip and sample surface is formed. Generally, adsorption force between a micro sphere and a flat surface can be represented as $F = 4\pi R \gamma$, Durjaguin approximation. In this paper, influence of surface roughness (R_{ms} : 0.25~12.8 nm), surface energy (40~69 mJ/m²) and relative humidity (4% and 40%) on micro tip adsorption is investigated. Consequently, in this study, it is clarified that surface roughness of the sample has strongly affected to the adsorption force. For the precise measurement of adsorption force, surface roughness at least less than 3 nm is required.

(Received : April 23, 1999)

The Effect of Acid Phosphate Compounds on Adhesion Properties of Acrylic Adhesives

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(Accepted for publication : September 20, 1999)

Effects of an acid phosphate compound having an acrylic group on various metal surface were studied with respect to adhesive properties of acrylic adhesive. Results had shown that substrates treated with the primer which contains acid phosphate compounds were superior to untreated substrate.

XPS spectra revealed the formation of strong ionic interactions between phosphate groups and metal surfaces. These formation could be achieved even if a metal oxide layer existed on a metal surface. Angular dependence of XPS spectra revealed that acrylic groups of acid phosphate compounds faced toward outside surface. It was supposed that acid phosphate compounds containing acrylic groups were expected to react to metals with the phosphate groups to make ionic interactions and react to adhesives with acrylic groups which face outside surface, to be involved polymerization; as a result bond strength increased and failure mode was improved.

(Received : July 5, 1999)

Thermomechanical and Adhesive Properties of Copolyimides with Alcoxysilyl Group in the Polysiloxane Segments

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(Accepted for publication : June 17, 1999)

Polysiloxane - *block* - polyimides with alcoxysilyl functionalities in polysiloxane segments, prepared from diethoxymethylsilane and polysiloxane - *block* - polyimides with vinyl group in polysiloxane segments by hydrosilylation reaction, were successfully synthesized, and the thermomechanical and adhesive properties were studied. The alcoxysilyl groups were carried out crosslinking reaction by hydrolysis and following condensation. The resulting materials were insoluble even in polar solvents. The cross-linked density was increased with polysiloxane composition. After the crosslinking reaction, the copolymer with 50 wt% of polysiloxane composition exhibited larger tensile modulus and lower thermal expansion coefficient. In addition, the thermal decomposition temperature was improved enormously in comparison with corresponding non-crosslinked copolymer. Furthermore, the copolymer films coated onto glass-plate was exhibited good adhesive properties even under highly temperature and under highly humid condition.

(Received : March 15, 1999)

Control of Catalytic Activity in Hydrosilylation Process by Using Imine Derivatives

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(Accepted for publication : October 9, 1999)

So as to control the catalytic activity of H_2PtCl_6 toward the hydrosilylation process, various imine derivatives were employed as an additive of the catalyst and their effect on the activity was evaluated. From the study on the hydrosilylation reaction of trimethylvinylsilane with triethylsilane at various temperatures, imine derivatives were found to act as a good retarder of the catalyst. The activity of Pt catalyst was dependent upon the substituents on the imine derivatives and also upon the quantity of the additive. The curing reaction of silicone resin was also carried out in the presence of imine derivatives, and the similar results to the model reaction were obtained. That is, the combination of H_2PtCl_6 and imines were found to be an excellent latent catalyst for the hydrosilylation process. The curing temperature of silicone resin was controllable by the character and the concentration of the imines employed.

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Journal of The Adhesion Society
of Japan, Vol. 36, No. 5 2000

CONTENTS

Original

- Adsorption Force Variation due to Wearing of Micro Tip Apex
on Cleaved Mica Surface Akira KAWAI [172]
“Gamo Triangles of Wetting” (Provisional Name)
and Re-verification of Dupre-Gamo Equation Hiroshi
TOMINAGA, Goro SAKATA, Tomomi ISHIBUCHI and
Masaharu OHMI [176]
Effects of Surface Treating Agents on Mechanical Properties of
Mica/Polyethylene Composites Yaomi KUMAGAI and
Charles W. Extrand [179]
Diffusion Behavior of Poly(isobutylene) on Poly(isobutylene)/
Paint Interfaces Masayoshi KAWABE, Keiji HAYASHI
and Shigeru KATAYAMA [185]

Review

- Repair and Reinforcement of RC Structures Using the Towsheet
Method
– Present Status and View on Repair and Reinforcement of
RC Structures Using Continuous Fiber Sheet- Shinkichi
MURAKAMI, Hiroyuki YOSHIZAWA, Makoto SAITO, Ma-
sami ENDO and Toshikazu TAKEDA [191]

IV. Surface Modification

- (5) Electron Beam (E.B) Equipment and Application Shinobu
KINOSHITA [201]
Introduction of Laboratory Takeshi YATSUKA [207]

“Gamo Triangles of Wetting” (Provisional Name) and Re-verification of Dupre-Gamo Equation

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(Accepted for publication : November 30, 1999)

“Gamo triangles of wetting” (provisional name) is proposed for a liquid droplet on a solid surface. Gamo triangles of wetting consists of two right-angled triangles that show balancing with the surface- or interfacial tension of a liquid droplet and a solid. Three useful equations on “the triangle of the work of adhesion” are obtained at once by Gamo triangles of wetting. And the verification of Dupre-Gamo equation is performed on contact angle θ over 90° . The results also coincide well with the theoretical curve of the specific work of adhesion as contact angle θ under 90° .

(Received : September 10, 1999)

Effects of Surface Treating Agents on Mechanical Properties of Mica/Polyethylene Composites

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(Accepted for publication : November 22, 1999)

The addition of mica to polyethylene yielded a composite with a modulus significantly higher than that of pure polyethylene. Fats, oils and fatty acids were investigated as prospective surface treating agents for mica reinforced polyethylene. Mica/polyethylene composites prepared with fats, oils and fatty acids in particular were compared with vinyltris(*t*-butyl peroxy) silane developed for nonpolar resins. Improvements in the tensile properties were observed with these agents as well as a 25 percent increase in the strength with the silane coupling agent, compared to a 50 percent increase with fatty acids. Fats and oils were less effective than fatty acids but similar to silane. Fatty acids also remarkably improved the impact properties. Fatty acids obtained from drying oils

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were found to be the most effective. The crosslinking reaction between coated mica surface and matrix resin proceeds by autoxidation of drying oils.

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Diffusion Behavior of Poly(isobutylene) on Poly(isobutylene)/Paint Interfaces

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(Accepted for publication : November 5, 1999)

This study investigates the diffusion of a poly(isobutylene) into an urethane resin paint. The presence of diffusion at the adhesive/polymer substrate interfaces is essential for the development of pressure sensitive adhesive tapes. Attenuated Total Reflectance Fourier Transform Infrared Spectroscopy (FTIR-ATR) studies have been used to characterize the diffusion behavior. The diffusion and reptation behavior were studied at various time intervals by measuring the changes in absorbance bands of selected characteristic peaks in each polymer. The amount of diffusion of poly(isobutylene) on poly(isobutylene)/paint interfaces greatly depended on the molecular weight of poly(isobutylene), and was proportional to the 1/4th power of time.

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Journal of The Adhesion Society
of Japan, Vol. 36, No. 6 2000

CONTENTS

Original

- Three-dimensional Finite Element Analysis of Stress Response
in Adhesive Scarf Joints Subjected to Impact Bending
Moments Izumi HIGUCHI, Toshiyuki SAWA
and Jyo SHIMURA [209]
- Synthesis of Polysiloxane-grafted Fluoropolymers and
Their Hydrophobic Properties Hiroshi SUZUKI, Toru
KOBAYASHI, Sinji SASAKI, Takashi KURIYAMA and
Makoto TAKEISHI [217]
- Effects of Additives on the Properties of Composite
Boards Prepared from Steam-exploded Beech Masahiro
TAKATANI, Setsu FUJITA, Takashi KITAYAMA, ^{the late}
Ryozo HAMADA and Tadashi OKAMOTO [225]
- Improvement of Adhering Strength of Fibrin by Using
Soluble Polypeptide. . . Kazuyuki JOKEI, Koichi UMIMOTO.
Masahito OKA and Toshio HAYASHI [231]

Review

- One-Part Technique of Epoxy Resin and Their
Adhesive Characterization Toshimitsu TAKEDA
and Hiroyuki OKUHIRA [236]

IV. Surface Modification

- (6) Sputtering and Vacuum Deposition Yoshiki
NAKAMURA, Yoshitaka SAKAMOTO and Jun-ichi
IWATA [241]

- Introduction of Laboratory** Kunio IKEMURA and Masaki
NISHINO [248]

Three-dimensional Finite Element Analysis of Stress Response in Adhesive Scarf Joints Subjected to Impact Bending Moments

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(Accepted for publication : March 2, 2000)

The stress wave propagation and the stress distribution in adhesive scarf joints of similar adherends subjected to impact bending moments are analyzed in an elastic deformation using three-dimensional finite-element method (FEM). An impact load is applied to a joint by dropping a weight. The one side of the adherend is fixed and the other side of the adherend is subjected to an impact load. FEM code employed is DYNA3D. The effects of scarf angles of the adherends, the adhesive thickness and Young's modulus of the adhesive on the stress wave propagation at the interfaces are examined. It is found that the maximum value of the Mises' equivalent stress σ_m appears at the interface of the adherend which is fixed. In the cases where the scarf angle is 45 and 60 degrees, the maximum value of the Mises' equivalent stress decreases. The maximum stress increases as the adhesive layer thickness decreases and as Young's modulus of adhesive increases. In addition, experiments were carried out to measure the strain response of adhesive scarf joints subjected to impact bending moments using strain gauges. A fairly good agreement is seen between the analytical and the experimental results.

(Received : May 11, 1999)

Synthesis of Polysiloxane-grafted Fluoropolymers and Their Hydrophobic Properties

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(Accepted for publication : December 10, 1999)

Hydrophobic hybrid polymers were synthesized by grafting end-reactive polydimethylsiloxanes onto fluoropolymers that have hydroxyl side chains. Sliding of water droplets

on the coatings prepared from the graft polymers was examined, in addition to measurements of contact angles, to evaluate hydrophobic properties of the polymeric materials. The sliding angle for water, which is defined as the angle at which a water droplet slides on a coating that is slowly tilted from the horizontal to the vertical position and gives an indication for interaction of water molecules with the materials, was discussed in relation to surface free energy of the coating. The relatively small sliding angles showed that the graft polymers are useful for practical uses as hydrophobic materials.

(Received : November 4, 1999)

Effects of Additives on the Properties of Composite Boards Prepared from Steam-exploded Beech

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(Accepted for publication : February 14, 2000)

A solid composite board was prepared by hot-pressing steam-exploded beech chips as the principal element. Steam-exploded beech powder (SE) was prepared by steaming beech chips at 210°C for 10 min, which induced significant thermoplasticity and moldability. A bakelite-like solid board was molded from SE under the pressure of 90 kgf/cm² at 160°C for 10 min. The mechanical properties of SE-alone boards with a density of 1.2 g/cm³ were: bending strength, 270 kgf/cm²; thickness swelling after 24 hr of immersion in water, 15.9%. On the other hand, the bending strength and thickness swelling of boards induced by the addition of 30 phr synthetic polymers to SE were 370 kgf/cm² and 4.65% with water-soluble phenolic resin, 439 kgf/cm² and 3.08% with alcohol-soluble phenolic resin, and 347 kgf/cm² and 5.69% with polystyrene, respectively. The boards made by the addition of 30 phr synthetic polymers showed good performance as compared with SE-alone boards.

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Improvement of Adhering Strength of Fibrin by Using Soluble Polypeptide

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(Accepted for publication : March 7, 2000)

Tissue adhesives have been prepared from fibrinogen, one of the clotting elements of blood. This material is commercially available as a closing, bone graft fixation, skin graft fixation, and other soft tissue fixation. On the other hand, the adhering strength of the fibrin glue has not been necessarily achieved until now, though many studies have been trying to improve the adhering strength. In this study, we tried to improve the adhering strength of fibrin glue by blending appropriate amount of soluble polypeptides, atecollagen as a natural polypeptide as well as poly(L-glutamic acid) as a synthetic polypeptide, into the fibrinogen aqueous solution. In addition, we studied whether it is effective to apply ultrasonic vibration technique just after mixing adhesives for a short time improving the adhering strength. It was found that the adhering strength of fibrin glue containing soluble polypeptide increased almost 2 times compared to the case without the polypeptide. Application of ultrasonic vibration onto the adhesive site for 1 min has been also found to be effective for increasing the adhering strength of the fibrin glue.

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