ABSTRACTS OF ORIGINAL ARTICLES
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Abstracts of Original Articles

1. Preparation of Synthetic Semipermeable Membranes. III. Cellulose nitrate and polyvinylpyrrolidone blend polymer
Akihiko Watanabe, Nobuo Nakabayashi and Eiichi Masuhara
Division of Organic Materials, Institute for Medical and Dental Engineering, Tokyo Medical and Dental University (Prof. Eiichi Masuhara)

A semipermeable membrane for hemodialysis was prepared from polyvinylpyrrolidone and cellulose nitrate. A 10% solution of the former (8 parts) and the latter (2 parts) in N,N'-dimethylformamide was spread on a clean glass plate and it was heated at 60°C for 2 hrs. and immersed in tap water. Good permeability of so-called middle molecules was characteristic in this membrane. (in Japanese)


2. New Symbolism for Electron Shifts in Resonance Theory. II.
New arrow symbolism for concurrent description of stereospecificities and selection rules in pericyclic electron shifts
Chikara Kamero
Division of Chemistry, Institute for Medical and Dental Engineering, Tokyo Medical and Dental University (Prof. Masayuki Ishikawa)

One of the most stimulating developments in organic chemistry has been the enunciation of selection rules for concerted reactions—Woodward-Hoffmann rules. An alternative approach based on the principle of aromatic transition states has also been developed by Dewar and Zimmerman. Inclusion of this principle in resonance (or electronic) theory has been successfully achieved by using solid (*) and non-solid (*) arrow symbols which not only indicate the electron shifts in a conventional sense but also specify the orbital arrays of a cyclic species of normal conjugated molecule or transition state of a pericyclic reaction. Thus, the new symbolism provides a method for concurrent description within the resonance theory, of electron shifts, stereospecificities, and selection rules for all pericyclic electron shifts occurring in either ground or excited electronic states. This article summarizes the original approach, extends it to a more generalized form, and describes some further examples of interest. (in English)


3. Analysis of Respiratory Rhythm Control through Electrical Stimulation of the Phrenic Nerve
Kenichi Ikeda, Makoto Noshiro and Shoji Suzuki
Division of Electronic Engineering, Institute for Medical and Dental Engineering, Tokyo Medical and Dental University (Prof. Kenichi Ikeda)

Synchronization phenomena of the respiratory rhythm with the external stimulation are analyzed in order to develop the portable respirator by electrical stimulation of the phrenic nerve.

Applying a single stimulation delayed in relation to the preceding inspiration, its effects on the interval between the stimulation and the following spontaneous inspiration are observed. The results obtained are called “the stimulation phase—inspiratory initiation time relation”, and show the two typical features: the stimulation causes the inspiration to be delayed when the stimulation phase doesn’t exceed the so-called switching time, and the stimulation evokes the inspiration when it does.

It is confirmed by experiments that this
4. Design of the Electro-pupilometer and the Instrumentation Systems for Pupil Dynamics

Kenichi Ikeda, Sadao Minami and Syoji Imai
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(Prof. Kenichi Ikeda)

We discussed the design method of the closed-circuit TV pupilometer, especially from two viewpoints and fabricated it.

From the viewpoint of the safety of infrared illumination against the eye, illumination power 1 mw/cm² was adopted, based on the fact of infrared exposed level of workers in glass or steel manufacturers and the calculation of infrared components in natural light exposed in our daily life.

From another viewpoint of the sensitivity and the dynamic performance which have never been discussed, we adopted silicon-vidicon tube, together with good optical system. Its sensitivity is enough under the level of safe infrared illumination. By processing TV video signal electronically, the area, vertical diameter and horizontal diameter of pupil can be measured. As the after image of this tube is reduced so much, the dynamic performance of this pupilometer is greatly improved to have the bandwidth of 10 Hz.

Together with this pupilometer, all the related instrumentations, such as optic and acoustic stimulation, other physiological state detectors, head resting equipment and so on, are designed and arranged systematically. (in Japanese)

5. Hodgkin-Huxley Equations as a Model for the Impulse Initiation Site of Mechanoreceptor Membrane

Shinji Miyazaki
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(Prof. Kenichi Ikeda)

Hodgkin-Huxley equations are introduced as a model for the impulse initiation site of mechanoreceptor membrane under the assumption that the membrane current of the equations corresponds to the receptor current induced by external mechanical stimuli. Numerical solutions of the equations for various waveforms of membrane current are calculated in order to examine the extent to which the characteristic response patterns of mechanoreceptors are explained by the equations. The results are as follows:

1) The response patterns of muscle spindle, such as initial bursts, pause after dynamic stretch and abrupt cease of firing, are well reproduced by the model due to the inherent differential characteristics of the equations.

2) Responses of the equations to AC membrane current superimposed upon DC bias show the characteristics of driving or synchronization which is observed in many mechanoreceptors. Responses of a rapidly adapting receptor are well simulated under the low DC bias condition, and those of a slowly adapting receptor are reproduced by the model with a high DC bias. (in Japanese)
6. Mean Systolic Shortening Power of Contractile Element as the Primary Determinant of Myocardial Oxygen Consumption

Hiroyuki Suga

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(Prof. Tatsuo Togawa)

A hypothesis was made that myocardial oxygen consumption (MVO₂) could be explicitly described as a linear function of mean systolic shortening power of the contractile element (MCEP). MCEP was defined as contractile element work divided by the duration of systole. It was considered that MCEP for stretching the series elastance (MCEP₁) and MCEP for external fiber shortening (MCEP₂) had different oxygen costs. The mathematical expression of the hypothesis is

\[ MVO₂ = \text{basal } MVO₂ + A \cdot MCEP₁ + B \cdot MCEP₂ \]

where A and B are the oxygen costs. The validity of this hypothesis was tested as follows. First, seven papers on MVO₂, which reported cardiodynamic data appropriate for the computation of MCEP, were selected from literature. Next, MCEP was calculated from them by the aid of both Hill's two-element model of myocardium and a thick-wall cylinder model of the left ventricular geometry. Finally, the correlation between MVO₂ and the calculated MCEP was examined by comparing them expressed as functions of various experimental parameters. The comparison showed that MCEP changed in proportion to MVO₂ under a variety of loading conditions and contractile states. The empirically fitted values for A and B were \( 2 \times 10^{-5} \) and \( 0.6 \times 10^{-2} \) (ml of O₂ per g cm/sec of MCEP), respectively. It is concluded that MCEP can be regarded as the primary determinant of MVO₂.


7. Accurate Measurement of Absolute Intraventricular Volume

Hiroyuki Suga

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Kichi Sagawa

Department of Biomedical Engineering, The Johns Hopkins University Medical School
(Prof. Tatsuo Togawa)

A simple volume transducer was developed in order to measure accurately the absolute internal volume of the isolated beating ventricle. The technique involved the replacement of the ventricular chamber with a water-filled balloon. The balloon was connected to a cylinder in which the volume of water was measured by its electrical conductivity. (in English)


Tatsuo Togawa and Tetsu Nemoto

Division of Instrumentation Engineering, Institute for Medical and Dental Engineering, Tokyo Medical and Dental University
(Prof. Tatsuo Togawa)

An improved device of the deep body thermometer presented by R. H. Fox and A. J. Solman in which zero-heat-flow method was applied, was described in this paper. In the transducer probe of the thermometer, the circumference of the probe was warmed to the same temperature as the center, so that the radial heat flow was compensated as well as the axial flow. Simulator experiments showed that the deep temperature could be measured from the surface of a rubber layer of 9 mm thick with the accuracy of 0.1°C. Medical applications of the thermometer to monitoring of the body temperature, measurement of the muscular temperature in exercise and peripheral temperature change to the cold environment were discussed. (in Japanese)

9. Studies on Zeolite as Polishing Agent of Dentifrice
Part 3. Some properties of synthetic zeolite
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NAOKI NAGATA
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In order to make use of Zeolite as a dentifrice, Synthetic Zeolites were examined about mineralogical properties, grain distribution, abrasiveness and effect of the active F-ion in Synthetic Zeolite pastes with fluorid.

Findings were as follows:
1) It was found by spectroanalysis and X-Ray diffraction that synthetic Zeolites had compositions of Si-Al-Na-Ca-Fe-Ti system and the crystal type was the Faujasite type.

2) Grain size of synthetic Zeolites scattered in narrow ranges of 1-5 µ. The shape of synthetic Zeolite was like cage, and grain distribution was approximately uniformity.

3) When the abrasive effect of synthetic Zeolite was tested on the cast silver alloy and on the cattle tooth enamel, the rate of surface reduction of synthetic Zeolites was lower than those of commercial dentifrices.

4) When colors of synthetic Zeolites were measured, their lightness was 82.9, and the hunter whiteness was 60.1 in Z-7.3 (Synthetic Zeolite-pH 7.3).

These values were quite near to those of commercial dentifrices.

5) Synthetic Zeolites were able to substitute Ca for Na.

Substitution rate of Ca in synthetic Zeolite was increased approximately 3 times higher than that of untreated synthetic Zeolite.

6) When NaF was mixed in synthetic Zeolite pastes, the quantity of F-ion little changed ever after 4 months.

7) Synthetic Zeolite leave much room for improvement in the lightness and the hunter whiteness by improving the manufacturing process. (in Japanese)

10. Thermal Properties of Inorganic Dental Materials during Setting
Part 4. Studies on some properties of various dental cements
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The four types of dental cements were mixed under various P/I ratio and their cal/g were measured by a twin conduction calorimeter at 20°C, and then the setting process of the four types of dental cements were measured from the exothermic curves, a durometer (A & E), a pH meter, and thermometer. Findings were as follows:

1) The exothermic curve of various dental cements figured the curve with one peak.

2) The value of cal/g and the final setting time of dental cement were controled by the starting material and the reaction product of cement.

3) The cal/g value of Zincphosphate cement obtained from the exothermic curve was 54.7 in the case of 3.5 P/I, and 90.7 in the case of 2 P/I. The value of Water-Stettable phosphate cement was 37.6 in the case of 7 P/I, and 37.7 in the case of 0 P/I. The value of Silicate cement was 53.9 in the case of 3.75 P/I and 57 in the case of 2.5 P/I. The value of Zincsilico-phosphate cement was 48.8 in the case of 2 P/I. The value of cal/g increased in the order Zincphosphate cement>Zincsilico-phosphate cement>Water-Stettable phosphate cement=silicate cement.

4) According to the exothermic curve of Zincsilico-phosphate cement, the reaction was complicated having the 2 phase-products. This value of cal/g was controled by Zincphosphate cement of them and the final setting time was controled by the Silicate cement of them.

6) It is estimated that the results of the
thermal properties seems to have the inter-
relation between the physical and mechanical
properties under the same condition in the
cement of a kind.
7) The setting process of dental cements
was classified 3 stages, such as the flow period,
the plastic period, and the hardening period.
(in Japanese)

11. Formation of Calcium
Phosphates in Aqueous
Solution at 37°C

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Tokyo Medical and Dental University
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Chiba Institute of Technology
(Prof. Kazuo Kato)

Calcium phosphates were synthesized by
reaction of CaCl₂ and Na₃HPO₄ aqueous solu-
tion with gentle stirring at 37°C, for 25 days.
The compositions of calcium phosphates were
extremely varied with pH. The calcium
phosphate which forms in solution of pH 5.3
or lower, was brushite (CaHPO₄.2H₂O), and
the one which forms in the solution of pH 5.8
or higher, noncrystalline hydroxyapatite, so
far as revealed from the X-ray pattern.
The results of X-ray diffraction and electron
microscopy showed that the noncrystal-
line hydroxyapatite converted into crystalline
with time, and that the crystal size of the
product after 25 days, was approximately
700 Å in length and 100 Å in width. Atomic
absorption spectrometric results indicated that
the Ca/P ratio of products was increased with
time.
The chemical formula of the noncrystalline
hydroxyapatite formed after 25 days, was pro-
posed to be Ca₁₀₋₇H₀₋₃(PO₄)₆₋₃.₅H₂O. (in Japa-
nese)

12. Development of a Handy Hot
Press Apparatus and its Application

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Tokyo Medical and Dental University
Takuji Sōkawa
Department of Industrial Chemistry,
Chiba Institute of Technology
(Prof. Kazuo Kato)

A handy hot press apparatus consisted of
a manual oil press and Pt resistance furnace,
was designed and constructed. This apparatus
employed alumina die bodies and punches
could be used on the hot pressing conditions
of 1000°C, 1000 kg/cm² and 1300°C, 200 kg/cm².

The hot pressing technique was applied to
fabrication of new ceramic materials from
three types of apatite, 1) synthesized noncry-
stalline apatite, 2) synthesized well-crystal-
lized hydroxy apatite, and 3) human enamel
apatite. Time, temperature and pressure of
1 hour, 900°C to 1100°C, and 130 kg/cm²,
respectively, were employed for this study.

When a noncrystalline hydroxyapatite were
hot-pressed at 130 kg/cm², 900°C, 1000°C and
1100°C, Knoop hardness of the products were
95, 125, 400 kg/mm² and the compressive
strength were 280, 580, 640 kg/cm².

It was concluded that the above hot press-
ing technique was expected to have a notice-
able effect on fabricate ceramic materials of
high density with fine grain size from syn-
thesized apatite, and that their physical
properties of Knoop hardness and compres-
sive strength were strongly dependent on
temperature. (in Japanese)
13. The Apportionment Loads of the Abutment Teeth and Elastic Properties

Hiroko Miyahira and Atsuyoshi Muramatsu
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We have been considered the mechanical studies on the dental bridges. And so the apportionment loads are determined to the supporting methods of the elastic properties of the teeth and spring constants, which are normal, transverse and rotating characteristics. Another factors on the apportionment loads are the dimensions and bending rigidity of the dental bridges and etc.

So, this paper investigated these factors on the apportionment loads. An elastic supports of the abutment teeth are considered with the spring constants of the normal and rotating directions.

And the pontics are constructed with many materials, and then bending rigidity are differentiated with these constructions.


14. The Mechanical Properties of the Lumbar Intervertebral Disc

Masahiro Nagai
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An experimental equation of the compressive load (P)—shrinkage (δ) relationship of the intervertebral disc is shown by $P = a(\alpha)\delta^\alpha$. The stiffness $a$ increases gradually with increasing loading speed $\alpha$. Therefore the intervertebral disc should be considered to be the viscoelastic body.

We used the solution (P-δ relationship) of linear viscoelasticity and obtained the equation of a-α relationship which was compared with the experimental results, however, the coefficients of viscoelasticity for the intervertebral disc were treated as a function of the shrinkage.


15. Some Experiments on Dendrite Structures

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Dendrite structures are often found in dental precise castings and in this paper, dendrite structures were studied morphologically by X-ray micro-analyser and micro-structures. Length, width and spacing of stalks and arms were measured respectively and the effects of solidification rate, content of added elements and temperature gradient at solid-liquid interface on their dimensional change were studied, and also distribution of solute content across these stalks and arms was obtained. (in Japanese) (Rep. Inst. Med. Dent. Eng., 7: 131–140, 1973)