Department of Chemical Science and Engineering,
School of Materials and Chemical Technology

Professor
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Specialized Fields

Chemical Engineering, Chemical Equipment Design, Material Science, Composite Materials, Corrosion Protection

Keywords

Polymeric Materials, Composites, Corrosion Control, Thermal Shock, Smart Structure, Green Composites, Evaluation, Lining, Epoxy Resin, RBI/RBM, Nondestructive Inspection

Lectures

Undergraduate: Inorganic Chemistry (Material Science), Chemical Equipment Design
Graduate: Adv. Chemical Equipment Design, Chemical Engineering for Adv. Mater. and Chem. Processing 1

Professional Career

Fellow, Inoue Gr., JST/Center for Research and Development Strategy（2006-2007）
Project Researcher, Center for Evaluation of Long-term Durability on Composite Materials, Kyoto Institute of Technology,（2006-2009）

1. Summary of Research and Goal

The mission of our laboratory is to improve the durability of chemical engineering equipments. We study on the fracture and degradation for polymeric materials and polymer composites, especially particle filled plastic composites.

2. Recent Research Topics

Evaluation of corrosive degradation on polymeric materials and composites

Plastic materials may be chemically degraded under corrosive environments, such as acid or alkali solutions and organic solvents. We are studying the mechanism of plastic corrosion and developing durable materials.

Smart materials for chemical equipment

Smart materials have been developed for crack or other mechanical damages. We are aiming to propose smart structures for chemical damages. The self detection function is created by using optical fiber and pH indicator, and the self healing or anti-aging function is tested.

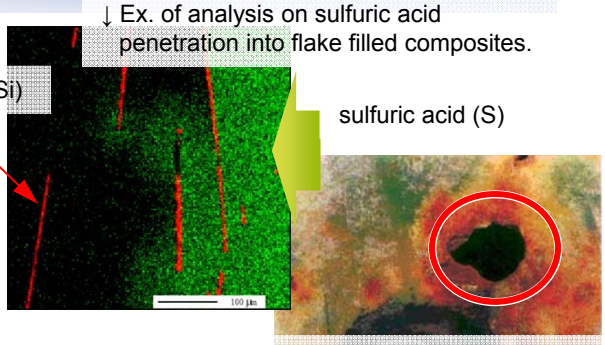
Evaluation and improvement of crack resistance on insulating resins (EP)

Epoxy resins are used as insulating materials for electric/ electronic purpose widely, but these materials sometimes show cracks under thermal shock. The quantitative evaluation method for thermal shock resistance was established and the improvement by filling inorganic filler was studied.

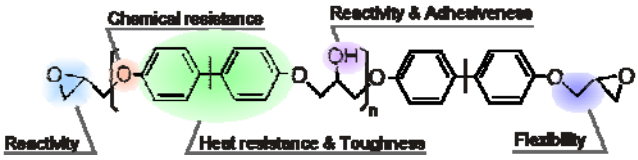
Risk Based Maintenance

Maintenance method using risk defined by probability of failure and consequence of failure is studied as applied on chemical equipment, especially organic materials using for anti-corrosion purpose.

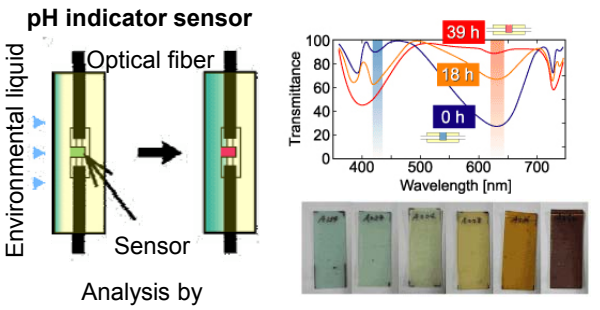
↓ Ex. of analysis on sulfuric acid penetration into flake filled composites.



Damaged part found in FRP storage for chloric acid ↑



Chemical structure of EP and the functions



Analysis by spectrophotometer

Self detection system for permeation of corrosive environment by pH indicator color change.

Evaluation of degradation of lining materials and life estimation

Lining materials are widely used in chemical plants; however, life estimation method are still not established. New lining testing equipment were designed and started to be evaluated under temperature gradient conditions.

Chemical recycling of polymeric composite materials

FRP is difficult to recycle. We had found the condition in which matrix epoxy resin will dissolve out quickly. Based on this phenomenon, a chemical recycling method is proposed. Now we are researching on an effective continuous process.

Creation of nano-particulate filled composites for high resistance to corrosion

Only small amounts of loading of nano-structural filler make plastics strong and have gas-barrier properties. From the anti-corrosion point of view, development of new clay-filled composites and their function analysis are studied.

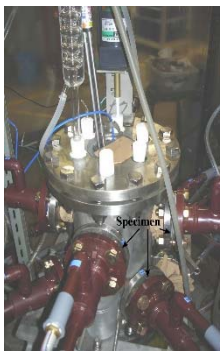
Development of natural fiber reinforced green composites

Natural fiber is used as reinforcement of new green composites. The fiber is taken from plants with high CO_2 absorption ability, and long-time stability and effective use of these materials are achieved.

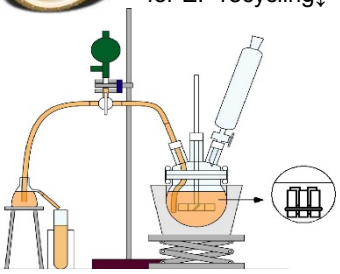
Degradation diagnosis of social infrastructure and evaluation of rehabilitation methods

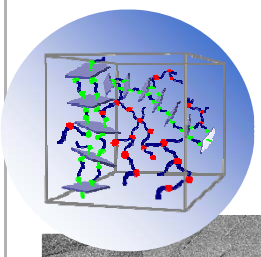
Japanese infrastructure constructed in days of high growth are now suffering from deterioration, especially underground piping that is serious prone to earthquake damages. Long-life estimation methods for rehabilitation materials are required to be established.

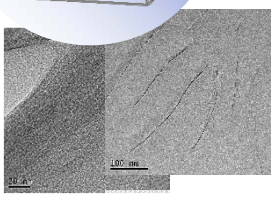
New designed lining testing equipment↓



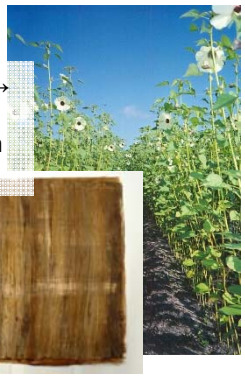
Continuous decomposing method for EP recycling↓





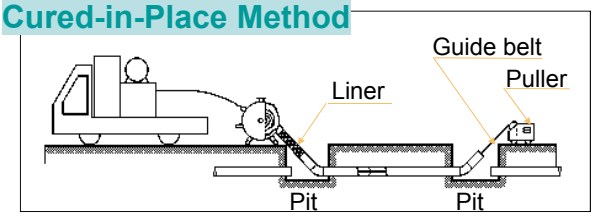


Kenaf plant →
Kenaf fiber sheet for high loading ↓



↑ Fully exfoliated nano scale clay in EP

Cured-in-Place Method



Rehabilitation method for old underground piping ↑

3. Results

Papers

M. KUSANO, T. SAKAI, Y. ARAO, M. KUBOUCHI, *Ultrasonics*, **82**(2018)pp.178-187
S.SUZUKI, M. KUBOUCHI, *J. High Pressure Inst. Jpn*, **55**,(2017)pp.35-43
M. KUSANO, M. KUBOUCHI , *et al.*, *eXPRESS Polymer Letters*, **10**, pp.941-949(2016)
A. H. SAPUTRA, M. SHOHIBI and M. KUBOUCHI, *Makara J. Technol.*, **19/3**, pp.133-140(2015)
M. KUSANO, M.KUBOUCHI , *et al.*, *J. Soc. Mater. Sci. Jpn.*, **52**, pp.220-224 (2015)
M. KUSANO, M.KUBOUCHI , *et al.*, *JRPS journal REINFORCED PLASTICS*, **61**, pp.445-450 (2015)
P. PRADCHAR, M.KUBOUCHI , *et al.*, *J. Chemical Engineering of Jpn.*, **48**, pp.670-677 (2015)
M. KUSANO, M.KUBOUCHI , *et al.*, *J. Soc. Mater. Sci. Jpn.*, **52**, pp.99-103 (2015)
M.KUBOUCHI , *et al.*, *J. Material System, Jpn.*, **31**, pp.37-42 (2013)
B.PAJARITO, M.KUBOUCHI, *et al.*, *J. Mater. Sci.*, **49**, pp.886-896 (2012)
B.PAJARITO , M.KUBOUCHI , *et al.*, *Advanced Composites Letters*, **21**, [6] pp.137-144 (2012)
W.KEYOONWONG, M.KUBOUCHI, *et al.*, *Intern. J. Corrosion*, 2012, #924283, 10pages (2012)
T.HAMAMURA, M.KUBOUCHI, *et al.*, *J. Mater. Life Soc., Jpn.*, 24, pp.95-101 (2012)
B.PAJARITO, M.KUBOUCHI, *et al.*, *ASEAN J. Chem. Eng.*, **12**, [1] pp.11-19(2012)
T.HAMAMURA, M.KUBOUCHI, *et al.*, *J. Soc. of Material Science, Jpn.*, **61**, [6] pp.537-542 (2012)
T.HAMAMURA, M.KUBOUCHI, *et al.*, *J. Japan Soc. Color Material*, **85**, [4] pp.138-143 (2012)
T.HAMAMURA, M.KUBOUCHI, *et al.*, *ZAIRYO-TO-KANKYO*, **61**, [4] pp.182-187 (2012)
P.N.D.NGUYEN, M.KUBOUCHI, *et al.*, *Clean Tech. and Environ. Policy*, **14**, #5, pp.943-951 (2012)
B.PAJARITO , M.KUBOUCHI , *et al.*, *J. Mater. Sci. and Tech., Jpn.*, **49**, [1] pp.32-38 (2012)
T.TUMOLVA, M.KUBOUCHI, *et al.*, *Mater. Sci. Tech., Jpn.*, **48**, pp.87-94 (2011)

Papers
T.HAMAMURA, M.KUBOUCHI, *et al*., *J. Mater. Sci. and Tech.*, **48**, [5] pp.258-263 (2011)
T.TUMOLVA, M.KUBOUCHI, *et al.*, *ASEAN J. on Chemical Eng.*, **10**, [1] pp.22-27(2010)
T.HAMAMURA, M.KUBOUCHI, *et al*., *J. Mater. Sci. Soc., Japan* , **47**, No.5 pp.244-251 (2010)

Books
"Epoxy Resin & Hardener Chemical Structure and How to Use a Subsidary Materials," NTS Inc., DVD (2016)
"Molding Technique and Characteristics of Continuous Fiber FRTP", G.Ben *Ed*., Nikkan Kogyo Shinbun, LTD., (2015) pp.1879-217
"Epoxy Resin for Electronic Components", A.Takahashi *Ed*.,CMC Publishiing *Co*., *Ltd*., (2015), pp.239-250
"Polymer Composites, Volume III Bio Composites", Wiley-VCH Verlag GmbH & Co.,(2014), pp.479-487
"The Latest Complete Filler Technology," Technical Information Institute *Co*., *Ltd*., Tokyo (2008) pp. 516-525
"The Current Issue Case Histories in Corrosion Failures Analysis and Corrosion Diagnosties", T.Ishihara *Ed*., Technosystem *Co*., *Ltd*., Tokyo（2007）pp.361-369
"Polymer Degradation and Stability Research Trends", Nova Sci. Pub., *Inc*., (2007) pp.61-89

Patent
Patent 2015-092938 "Cured Material and Processing Method of Thermosetting Resin"
Patent 2012-227493 "Thermosetting Resin Composition"
Patent H11-295631 "Monitoring method and equipment for Chemical Change"

Project
The research project "Survey of corrosion sensing equipment that can be used in inaccessible places" on JST
"Development of Systems and Technology for Advanced Measurement and Analysis" at JST.
The research project on JSPS "180th Committee on Risk-Based Plant Management "

Award
The MSSJ Prize in Applied Research and Engineering, (Jun. 2016).
The MSSJ Prize for Excellent Original Paper, (Jun. 2012).
The Research Award, Japan Thermosetting Plastics Industry Association, (Oct. 2008).
The Best Review Paper Award, Material Life Society, Japan (Jun. 2005).
Technology award（Japan Soc. Cor. Eng.）(2002) ,
19th I.O.T. award (Japan Thermosetting Plastics Industry Association) (1995)

4.Activities

Univ. Committee
Associate Dean for Finance and Safety in the School of Materials and Chemical Technology (2016-2017)
Chair of Department of Chemical Engineering (2014-2015)
the Course Coordinator of IGP-A/MCP, Adv. Material and Chemicals Processing Course (2012-2017)

Academic Soc.
President of Material Science Society of Japan (2013-2017), Vice-president (2009-2013)
Chair of the Plant Materials Engineering Committee in the Society of Chemical Engineers, Japan, (2013-2017), Vice-Chair (2006-2013)
Head of the Industrial, Chemical Machinery and Safety Div. in the Japan Soc. of Mechanical Engineering (2011) Vice-head (2010)
Advisory Board in the Plastic Lining Association (2004-2016), the Epoxy Resin Engineers Association (2005-2016) and the Japan Concrete Erosion Prevent Association (2008-)
Award selection board in the Material Science Society of Japan (2014-) and the Japan Thermosetting Plastics Industry Association (2001-2005)

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Assistant Professor

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Dr.of Engineering

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Research Fields
Mechanics of materials, Composite materials, Chemical equipment materials

Keywords
Composite materials, Epoxy, Corrosion protecting, Nanocomposites, Green composites, Material test

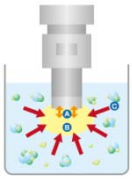
1. Scope of Research

We've investigated how to improve the productivity of graphene, which shows the best mechanical, thermal and electrical properties. Creating new concept of production plants for graphene is our main topic.
We'll try to apply the obtained graphene to anti-corrosion, gas barrier and high-durable materials.

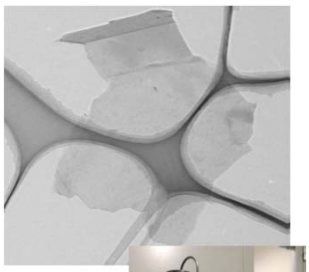
2. Research Topics

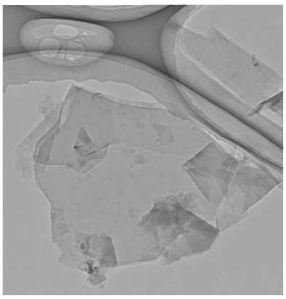
Exfoliation of layered material

It has been found that layered materials such as graphite, MoS_2, and BN show extraordinary performance when they are completely exfoliated. The single layer of graphite is named “Graphene” and it shows the best mechanical, thermal and electrical properties. However, the production rate of graphene is extremely low (below 10g/h). Thus, the cost of these attractive material is high, and they are not available for commercial application. In our laboratory, we are investigating how to apply the shear stress to these layered material, and developing the lab-scale plant which can exfoliate the materials efficiently. The exfoliated materials tend to aggregate, so we are also groping proper surfactants that can stabilize the exfoliated material. We’re developing a cost effective and scalable production plant in order to make high-performance nanomaterials into commercial application.



Sonication



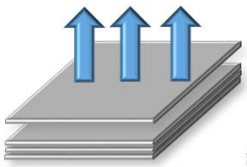


Pressure homogenizer

Development of functional nanocomposites

Layered nanomaterial such as graphene can act as anti-corrosion and gas barrier material. Technical problem to take advantages of nanomaterial is dispersing them in a polymeric material without reduction of their high-aspect ratio. Thus, we’re developing various material process to make high-performance nanocomposites. We’re using layered nanomaterials for not only anti-corrosion material but also high thermal conductive material, transparent conductive films and fracture toughened epoxy. These properties can not be obtained for commercial polymer.

Normal force



Shear (lateral) force

3. Publications and Activities

Paper:

- Y. ARAO, F. MORI and M. KUBOUCHI, *Carbon*, **118**, pp.18-24（2017）
- Y.ARAO, Y.MIZUNO, K.ARAKI. M.KUBOUCHI, *Carbon,* **102**, pp.330-338 (2016.6)
- Y.ARAO, M.KUBOUCHI, *Carbon,* **95**, pp.802-808 (2015.12)
- Y.Arao, T.Fukui, T.Niwa, H.Kawada, *Journal of Composite Materials* (in printing)
- Y.Arao, T.Fujiura, S.Itani, T.Tanaka, *Composite Part B*, **68**, 200-206 (2015).
- A.Inoue, K.Morita, T.Tanaka, Y.Arao, Y.Sawada, *Journal of Composite Materials*, **49**, 75-84 (2015).
- K.Natori, K.Katanoda, Y.Hashimoto, Y.Arao, T.Tanaka, *Key Engineering*, **627**, 61-64 (2015).
- Y.Arao, S.Nakamura, Y.Tomita, K.Takakuwa, T.Umemura, T.TanakaI, *Polymer Degradation and Stability*, **100**, 79-85 (2014)
- K.Araki, S.Kaneko, K.Matsumoto, A.Nagatani, T.Tanaka, Y.Arao, *Advanced Materials Research*, **844**, 318-321 (2014)
- K.Natori, R.Kishi, Y.Arao, T.Tanaka, *High Performance and Optimum Design of Structure and Materials*, **137**, 151-162 (2014).
- A.Inoue, T.Tanaka, Y.Arao M.Nomoto, S.Shimokusuzono., *Seikei Kako*, **26**, 279-285, (2014)
- Y.Arao, S.Yumitori, H.Suzuki, T.Tanaka, K.Tanaka T.Katayama., *Composite* Part A, **55**, 19-26 (2013)
- S.Yumitori, Y.Arao, T.Tanaka, K.Tanaka, T.Katayama., *WIT Transactions on the Built Environment*, 275-284 (2013).
- K.Natori, T.Kobayashi, S.Tatsuta, T.Tanaka, Y.Arao, *WIT Transactions on the Built Environment*, 339-349, (2013).
- Y.Arao, T.Otoshi, T.Tanaka,*Transactions of the JSME,* **79**, 1239-1251 (2013).
- T.Niwa, Y.Arao, H.Kawada, *Transactions of the JSME ,* **79**, 950-960 (2013).
- Y.Arao, N.Taniguchi, T.Nishiwaki, N.Hirayama, H.Kawada, *Journal of Material Science*, **47**, 4895-4903 (2012).
- N.Taniguchi, Y.Arao, T.Nishiwaki, N.Hirayama, K.Nakamura, H.Kawada, *Advanced Composite Materials*, **21**, 165-175 (2012).
- N.Keiko, N.Fumiya, Y.Arao, T.Tanaka, *WIT Transactions on the Built Environment*, 339-349 (2012).
- N.Inoue, N.Taniguchi, T.Nishiwaki, N.Hirayama, K.Nakamura, Y.Arao, H.Kawada, *Transactions of the JSME,* **78**, 1284-1299 (2012).
- Y.Arao, J.Koyanagi, S.Utsunomiya, H.Kawada, *Composite Structure*, **93**, 1225-1230 (2011).
- Y.Arao, Y.Okudoi, J.Koyanagi, S.Takeda, H.Kawada, *Mechanics of Time-Dependent Materials*, **16**, 69-180 (2011).
- Y.Arao, J.Koyanagi, S.Takeda, S.Utsunomiya, H.Kawada, *Transactions of the JSME,* **77**, 38-47 (2011).

Book:

- “Flame Retardants: Polymer Blends”, Composites and Nanocomposites, 2015, *Springer*
- “Thermal degradation of Polymer Blends”, Composites and Nanocomposites , 2015, *Springer*