creases the free energy of the reaction while the membrane itself separates reactants from products. The knowledge accumulated in micellar and macromolecular catalysis (Fendler and Fendler, 1975) could be profitably transferred to membrane reactor applications. Appropriately constructed polymeric membranes can also find important applications in controlled release technologies and target direct drug deliveries. Within the foreseeable future, we shall witness the emergence of major new technologies based on polymeric membranes.

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Literature Cited

Ackerman, R.; Inacher, O.; Ringsdorf, H. *Kolloid Z. Z. Polym.* **1971**, *249*, 1118–1126.
Akimoto, A.; Dorn, K.; Gros, L.; Ringsdorf, H.; Schupp, H. *Angew. Chem. Eng.* **1981**, *20*, 90–91.
Albrecht, O.; Johnston, D. S.; Villaverde, C.; Chapman, D. *Biochim. Biophys. Acta* **1982**, *687*, 165–169.
Barrand, A.; Rosilio, C.; Raudel-Teixier, N. *Thin Solid Films* **1980**, *68*, 7–12, 91–98, 99–106.
Bubeck, C.; Tieke, B.; Wegner, G. *Ber. Busenges. Phys. Chem.* **1982**, *86*, 495–498.
Calvin, M. *Acc. Chem. Res.* **1978**, *11*, 369–374.
Day, D.; Ringsdorf, H. *J. Polym. Sci. Polym. Lett.* **1978**, *16*, 205–210.
Day, D.; Lando, J. B. *Makromolecules* **1980**, *13*, 1478–1483, 1483–1487.
Day, D.; Lando, J. B. *J. Appl. Polym. Sci.* **1981**, *26*, 1605–1612.
Day, D.; Ringsdorf, H. *Macromol. Chem.* **1979**, *180*, 1059–1063.
Fendler, J. H. *Acc. Chem. Res.* **1980**, *13*, 7–13.
Fendler, J. H. *J. Phys. Chem.* **1980**, *84*, 1485–1491.
Fendler, J. H. *Pure Appl. Chem.* **1982**, *54*, 1809–1819.
Fendler, J. H. "Membrane Mimetic Chemistry", Wiley-Interscience: New York, 1982.
Fendler, J. H. *Chem. Eng. News* **1984**, *25* (1), 25–38.
Fendler, J. H. In "Surfactants in Solution", Mital, K. L.; Lindman, B., Ed.; Plenum Press: New York, 1984.
Fendler, J. H.; Fendler, E. J. "Catalysis in Micellar and Macromolecular Chemistry", Academic Press: New York, 1975.
Fendler, J. H.; Romero, A. *Life Sci.* **1977**, *20*, 1109–1120.
Fendler, J. H.; Tundo, P. *Acc. Chem. Res.* **1984**, *17*, 3–8.
Fuhrhop, J. H.; Batsch, H.; Fritsch, P. *Angew. Chem. Int. Ed. Engl.* **1981**, *20*, 804–805.
Fuhrhop, J. H.; Mathieu, J. *J. Chem. Soc., Chem. Commun.* **1983**, 144–145.
Gaines, G. L., Jr. "Insoluble Monolayers at Liquid-Gas Interfaces", Interscience: New York, 1966.
Gratzel, M. *Acc. Chem.* **1981**, *14*, 376–384.
Gregoriadis, G. "Drug Carriers in Biology and Medicine"; Academic Press: London, 1979.
Hupfer, B.; Ringsdorf, H.; Schupp, H. *Makromol. Chem.* **1981**, *182*, 247–253.
Ishiwatari, T.; Fendler, J. J. *J. Am. Chem. Soc.* **1984**, *106*, 1908–1912.
Johnston, D. S.; McLean, L. R.; Whittam, M. A.; Clark, A. D.; Chapman, D. *Biochemistry* **1983**, *22*, 3194–3202.
Kavanau, L. "Structure and Function in Biological Membranes"; Holden-Day: San Francisco, 1964.
Kesting, R. E. "Synthetic Polymeric Membranes"; McGraw-Hill: New York, 1971.
Kimelberg, H. K.; Mayhew, E. G. *CRC Crit. Rev. Toxicol.* **1978**, *6*, 25–79.
Kippenberger, D. J.; Rosenquist, K.; Odberg, L.; Tundo, P.; Fendler, J. H. *J. Am. Chem. Soc.* **1983**, *105*, 1129–1135.
Koch, H.; Ringsdorf, H. *Makromol. Chem.* **1981**, *182*, 255–262.
Kuhn, H.; Mobius, D.; Bucher, H. In "Physical Methods for Chemistry", Vol. 1, Part III B, Weissberger, A.; Rossiter, B. W., Ed.; Wiley-Interscience: New York, 1972; pp 577–701.
Kunitake, T.; Sakamoto, T. *J. Am. Chem. Soc.* **1978**, *100*, 4615–4617.
Kunitake, T.; Okahata, Y.; Audo, R.; Shinka, S.; Hirakawa, S. *J. Am. Chem. Soc.* **1980**, *102*, 7877–81.
Kunitake, T.; Ihara, H.; Okahata, Y. *J. Am. Chem. Soc.* **1983**, *105*, 6070–6078.
Kurihara, K.; Fendler, J. H. *J. Am. Chem. Soc.* **1983**, *105*, 6152–6153.
Lieser, G.; Tieke, B.; Wegner, G. *Thin Solid Films* **1980**, *68*, 77–85.
Loeb, S.; Sourirajan, S.; UCLA Report, 1960, p 60.
Maoz, R.; Sagiv, J. *J. Colloid Interface Sci.* **1984**, in press.
Mobius, D. *Acc. IChem. Res.* **1981**, *14*, 63–68.
Moss, R. A.; Bizzigotti, G. O. *Tetrahedron Lett.* **1982**, *23*, 5235–5238.
Moss, R. A.; Schreck, R. P. *J. Am. Chem. Soc.* **1983**, *105*, 6767–6768.
Moss, R. A.; Shin, J. J. *J. Chem. Soc., Chem. Commun.* **1983**, 1027–1028.
Moss, R. A.; Ihara, Y.; Bizzigotti, G. O. *J. Am. Chem. Soc.* **1982**, *104*, 7476–7478.
Naegele, D.; Lando, J. B.; Ringsdorf, H. *Macromolecules* **1977**, *10*, 1339–1344.
Netzer, L.; Iscovici, R.; Sagiv, J. *Thin Solid Films* **1983**, *99*, 235–241.
Netzer, L.; Sagiv, J. *J. Am. Chem. Soc.* **1983**, *105*, 674–676.
Porter, G. *Proc. R. Soc. London Ser. A.* **1978**, *362*, 281–303.
Reed, W.; Guterman, L.; Tundo, P.; Fendler, J. H. *J. Am. Chem. Soc.* **1984**, in press.
Regen, S. L.; Singh, A.; Oehme, G.; Singh, M. *J. Am. Chem. Soc.* **1982**, *104*, 791–795.
Singer, S. J.; Nicholson, G. L. *Science* **1972**, *175*, 720–731.
Tieke, B.; Wegner, G. *Makromol. Chem.* **1978**, *179*, 1639–1642.
Tundo, P.; Kippenberger, D. J.; Politi, M. J.; Klahn, P.; Fendler, J. H. *J. Am. Chem. Soc.* **1982**, *104*, 5352–5358.
Tundo, P.; Kurihara, K.; Kippenberger, D. J.; Politi, M.; Fendler, J. H. *Angew. Chem., Int. Ed. Engl.* **1982**, *21*, 81–82.
Tyrrell, D. A., Heath, T. D., Colley, C. M.; Ryman, B. E. *Biochim. Biophys. Acta* **1976**, *457*, 259–302.
Whitten, D. G. *Angew. Chem., Int. Ed. Engl.* **1979**, *18*, 440–405.

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Ultraviolet Radiation Curable Paints

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In product finishing lines, ultraviolet radiation curing of paints on prefabricated structures could be more energy efficient than curing in natural gas-fired ovens. Diffuse ultraviolet light cures paints on three-dimensional metal parts. The spectral output of radiation sources must complement the absorption spectra of pigments and photoactive agents so that highly pigmented (>35% by weight) thick (>25 μm) films can be fully cured by UV radiation. Photosensitive compounds such as thioxanthones are used to photoinitiate unsaturated resins such as acrylated polyurethanes in paints cured by a free-radical mechanism. Cationic photoinitiators such as sulfonium or iodonium salts of complex metal halide anions are used in the polymerization of epoxy paints by ultraviolet radiation.

Introduction

The Westinghouse Electric Corp. has completed a program to develop ultraviolet light curable paints for application on three-dimensional objects representing typical industrial items. This program was sponsored by the U.S. Department of Energy in an effort to evaluate a more energy-efficient technique than direct fired gas ovens which traditionally have been used for curing paint films on metal substrates such as appliances, metal furniture, automobiles, and other fabricated metal parts. The goal of this program

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