US005158720A

United States Patent [19]

Levy

[11] Patent Number: 5,158,720

[45] Date of Patent: Oct. 27, 1992

[54] METHOD AND SYSTEM FOR CONTINUOUS IN SITU MONITORING OF VISCOSITY

[75] Inventor: **Ram L. Levy**, Creve Coeur, Mo.

[73] Assignee: **McDonnell Douglas Corporation**, Creve Coeur, Mo.

[21] Appl. No.: **430,098**

[22] Filed: **Aug. 28, 1990**

Related U.S. Application Data

[63] Continuation of Ser. No. 161,351, Feb. 22, 1988, abandoned, which is a continuation of Ser. No. 806,493, Dec. 9, 1985, abandoned.

[51] **Int. Cl.**[5] **B29C 35/02**; G01N 21/64

[52] **U.S. Cl.** **264/21**; 250/227.14; 264/40.1; 264/40.2; 356/133; 436/55; 436/172

[58] **Field of Search** 264/21, 40.1, 40.2; 436/55, 172; 250/227.14; 356/133

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,659,974	5/1972	Neugroachl	425/29
3,791,792	2/1974	Lindsay	264/40.2 X
3,935,053	1/1976	Armstrong, Jr.	264/40.2 X
4,003,707	1/1977	Lübbers, et al.	436/68 X
4,044,600	8/1977	Claxton et al.	73/15 R
4,075,493	2/1978	Wickersheim	250/461 R
4,215,275	7/1980	Wickersheim	250/459
4,312,228	1/1982	Wohltjen	73/597
4,346,599	8/1982	McLaughlin et al.	73/597
4,440,699	4/1984	Smid et al.	264/40.2 X
4,455,268	6/1984	Hinrichs et al.	264/40.2 X
4,510,103	4/1985	Yamaguchi et al.	264/40.2
4,904,080	2/1990	Afromowitz	356/133

OTHER PUBLICATIONS

Oster, et al., J. Am Chem. Soc., 78, 1581 (1956) "Fluorescence and Internal Rotation".

Sharafy et al. J. Am. Chem. Soc., 93, 4119 (1971) Viscosity Dependence of Fluorescense Quantum Yields.

Law, Chemical Physics Letters, 75, 545 (1980) Fluorescence Probes for Microenvironments.

Law, Photochemistry and Photobiology, 33, 799 (1981) Fluorescence Probes for Microenvironments.

Loutfy, Macromolecules, 14, 270 (1981) High Conversion Polymerization Fluorescense Probes.

Senturia, et al., J. Adhesion, 15, 69 (1982) In-Situ Measurement of the Properties of Curing Systems.

Förser, et al. Z. Phys. Chem, 75(1-2), 63 (1971) Effect of Viscosity on the Fluorescense Yield of a Dye.

Loutfy, J. Polymer Sci, 20,825 (1982) Fluorescence Probes for Polymerization Reactions.

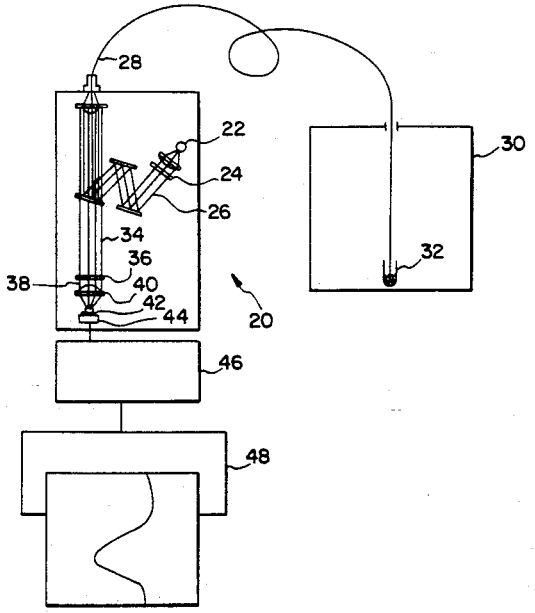
Loutfy, et al., Macromolecules, 16, 452 (1983) Effect of Polymer Chain Tacticity on Fluorescence.

Levy, Am. Chem Soc. Apr. 1984 Viscosity Dependent Self-Probe Fluorescence of an Epoxy Resin.

Primary Examiner—Jill Johnston

Attorney, Agent, or Firm—Edward H. Renner

[57] **ABSTRACT**

An apparatus and method for in situ monitoring the viscosity and cure of resins using viscosity dependent fluorescence uses a fiber optic waveguide to introduce light to the resin of a wavelength exciting fluorescence and to conduct the emitted light to a monitor. The emitted light parameters correlate to the viscosity and cure conditions of the resin. The apparatus and method may be used to control composite construction and to provide information on the in service condition of composites.

13 Claims, 6 Drawing Sheets