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Nakamura et al.

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(54) **MULTILAYER TUBE FOR TRANSPORTATION**

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See application file for complete search history.

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(56) **References Cited**

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U.S. PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

4,971,726 A 11/1990 Maeno et al.
5,643,990 A 7/1997 Uehara et al.

(Continued)

This patent is subject to a terminal disclaimer.

FOREIGN PATENT DOCUMENTS

EP 1 300 364 A2 4/2003
EP 1 637 563 A1 3/2006

(Continued)

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OTHER PUBLICATIONS

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Lin et al. entitled "Dynamical Observation of Bamboo-like Carbon Nanotube Growth", Nano Letters, vol. 7, No. 8, p. 2234-2238, 2007.*

(Continued)

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(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

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There is provided a multilayer tube for transporting a fuel, a chemical liquid or a gas, which is based on a thermoplastic resin, in particular a polyamide resin, wherein its inner layer comprises an electroconductive thermoplastic resin in which a fine carbon fiber has been blended as an agent imparting an electroconductivity, and it excels in a molding processability, a fuel oil resistance and an antistatic property. This multilayer tube comprises at least two layers of (a) an outer layer comprising a thermoplastic resin, and (b) an inner layer comprising an electroconductive thermoplastic resin so that a surface resistivity is not more than $10^8 \Omega$; the electroconductive thermoplastic resin comprising a fine carbon fiber, wherein a graphite-net plane consisting solely of carbon atoms forms a temple-bell-shaped structural unit comprising closed head-top part and body-part with open lower-end, 2 to 30 of the temple-bell-shaped structural units are stacked sharing a common central axis to form an aggregate, and the aggregates are connected in head-to-tail style with a distance to form the fiber.

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F16L 11/127 (2006.01)

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(52) **U.S. Cl.**

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(58) **Field of Classification Search**

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8 Claims, 4 Drawing Sheets

