

Nanofibers of aluminum oxide

Nafen is produced from melt: industrial-scale technology











TEM micrographs / SAXS data







Parameter	value
Phase	gamma / chi ~ 15:85 *
Mean fiber diameter, nm	7-10
Fiber length, mm	1–150
Specific surface area (BET), m ² /g	100-150
Purity, %	99.7
Bulk density, g/cm ³	0.1 to 0.4

 * - phase composition can not be accurately quantified because of lack of structure model for $\chi\text{-phase}$

Is it unique?



Reference 1: AIOOH "aerogel" (FEI)

Reference 2: Nano Technology Inc. (Korea):

"diameter is approximately 5-10 nm, and the aspect ratio is in the 50 to 200 range"



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3258 Bull. Korean Chem. Soc. 2012, Vol. 33, No. 10 http://dx.doi.org/10.5012/bkcs.2012.33.10.3258 Byung-Joo Kim et al.

Effects of Surface Nitrification on Thermal Conductivity of Modified Aluminum Oxide Nanofibers-Reinforced Epoxy Matrix Nanocomposites

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Mechanical properties of individual fiber



Calculation of Elastic modulus, fracture strength, and fracture energy of Nafen fibers



$$E = \frac{FL^3}{192d_n I} = \frac{K_n L^3}{192I}$$

where I is the moment of inertia, L is the suspended length of the sample, and F is the applied load at its midpoint position. K_n , the spring constant of the sample.

Calculation of fracture strength



 $\sigma = \frac{FL}{2\pi r^3}$

Where F is load when the nanowire cracks, L is the suspended length of the sample; r is the radius of nanowire.

CNTs (Wiki):

Young's modulus on the order of 270 - 950 GPa and tensile strength of 11 - 63 GPa

Phase analysis (XRD)





High-temperature phase transformation (XRD)





The surface is 'saw-shaped' (TEM)







Main application: reinforcing filler for thermoset-based adhesives



EP-PP copolymers: "as co-monomer"

Surface treatment type affects the performance, including level of TOD stability enhancement



Technological challenges & solutions





Ultrasonic dispersion and/or targeted surface treatment (functionalization) allows good (almost to single fiber) level of dispersion

Surface chemistry





IR spectroscopy / CO absorption:

only weak and medium-strength Brønsted and Lewis centers are present:

max Q(LC) = 39 kJ/mole - considerably lower than for "conventional" Al_2O_3 types

Nafen as support for heterogeneous catalysts: first trials



1) HDC of halogen-aromatic compounds: application for waste treatment (unpublished) 2) Emulsion hydrogenation of substituted phenols (unpublished data):

23 compounds tested





- 1) low-T Al₂O₃ polymorph
- 2) relatively high SSA and "highly-defective" surface: allows easy anchoring of catalytically active components
- 3) low acidity: no / minimal side reactions \rightarrow selectivity
- 4) surface chemistry can be tailored:
 - three subtypes of Nafen available
 - functionalization is possible
- 5) ready masterbatches for liquid dispersion type processes can be produced
- 6) "bonus" reinforcement effect (?)



Thank You for Attention