Advanced Functional Materials

Carbon Microcoils（CMC)

Properties and Potential Applications

Carbon microcoil (CMC), which have an interesting 3D-helical/spiral structure with a coil diameter of 0.1-50 μm, are prepared by the catalytic pyrolysis of acetylene. The CMC can be applicable as microwave absorbers, tactile sensors elements, bio-activators, microantenna, electrode, chiral catalysts, etc.

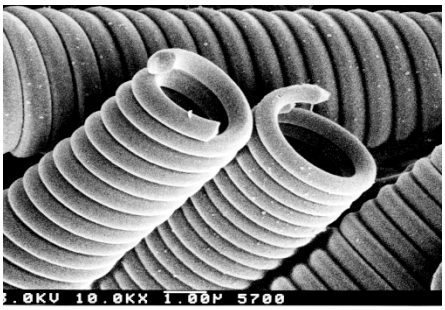


Fig. 1 Coiling-chirality of double-helix carbon microcoils.
R:right-hand coiling, L:left-hand coiling.

Table 1

Characteristics and Properties of the Carbon Micro-coils

Morphology	: Double Helix
Coil Diameter	: 1-10 μm
Coil Pitch	: 0.01-5 μm
Coil Length	: 0.1-10 mm
Fiber Diameter	: 0.01-1 μm
Elasticity (Extension Ratio)	: 1.5-10 times
Chemical Composition (wt%)	: C=97.5-98.2 H=1.0-1.4 S=0.03-0.09
Crystallographic structure	: Amorphous
Density	: 1.81-1.88 g/cm³
Specific Surface Area	: 100-140 m²/g
Specific Electrical Resistivity	: 10-0.1 Ωcm
Thermal Conductivity (Bulk)	: 0.0446 W/m/k (for 0.0884 g/cm³) 0.0562 W/m/k (for 0.2055 g/cm³)

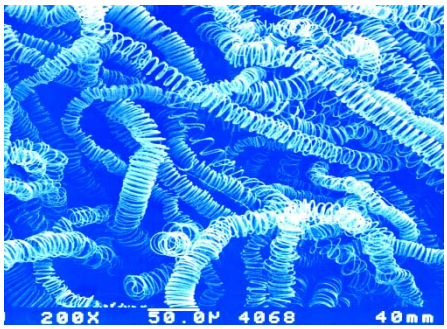


Fig. 2 Super-elastic carbon microcoils with large coil diameters.

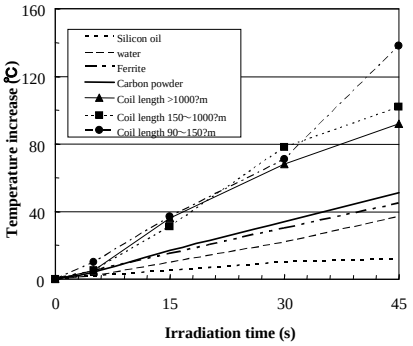


Fig. 4. Temperature Increase of CMC(1wt%) /silicone oil by microwave heating

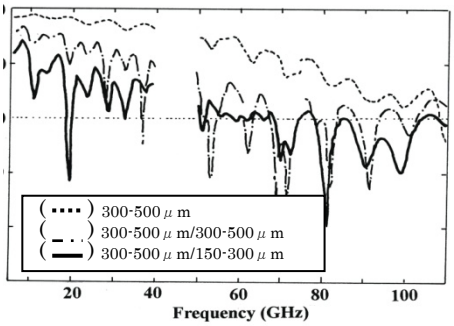
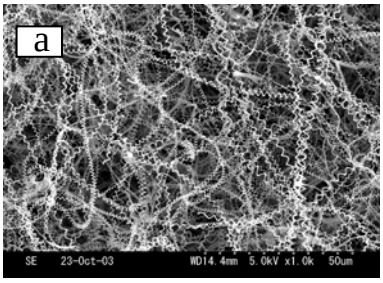


Fig. 5 Reflection loss of carbon microcoils for microwaves.



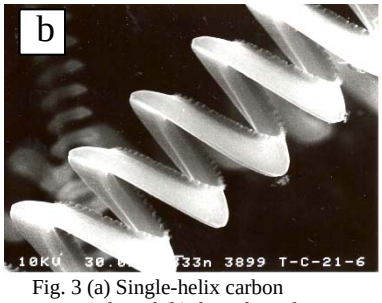


Fig. 3 (a) Single-helix carbon microcoils and (b) the enlarged view.

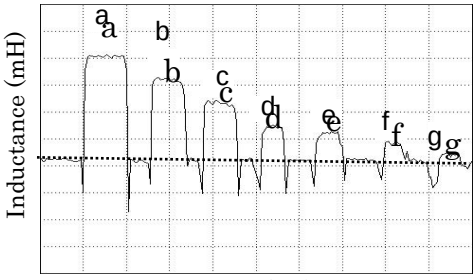
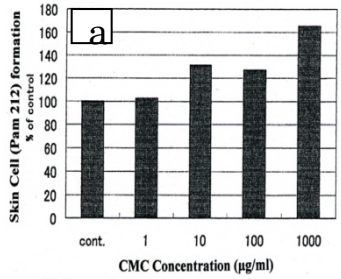


Fig. 7 Inductance changes under applying small loads.
Dotted line indicates without applying load.
Load: (a) 200mgf, (b) 100mgf, (c) 50mgf, (d) 20mg, (e) 10mgf, (f) 5mgf, (g) 1mgf.



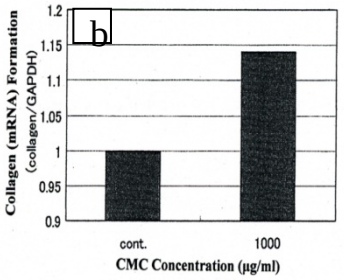


Fig. 6 Activation effect of CMC on the (a) breeding of skin cells and (b) collagen fibrils.

Table 2 Potential application of CMC

1	Electromagnetic absorbers	(1) Beads (2) Foams (3) Ceramic beads (4) Super-thin EM absorbers
2	Tactile sensors	(1) Medical sensors (2) Humanoid robot sensors (3) Artificial skins with tactile sensing properties (4) Aerospace sensors (5) Industrial sensors
3	Bio-activators	(1) Breeding or activating catalysts for skin cells, collagen fibrils, microorganisms, etc. (2) Activators of metabolism (3) Tissue engineering
4	Micro-antenna	(1) Micro-antenna for aerospace (2) Energy converters
5	Remote-heaters	(1) Remote micro-heaters (2) Micro-heaters for DDS
6	Others	(1) Super-elastic conductors (2) CMC containing fibers (3) etc.

Correspondence:
Prof. S. Motojima. Department of Applied Chemistry, Faculty of Engineering, Gifu University, Gifu 501-1193, Japan
(e-mail:motojima:apchem.gifu-u.ac.jp)