

*KURNS meeting 1. April. 2021*

---

# Progress of BPM and WSM developments

---

E. Yamakawa

---

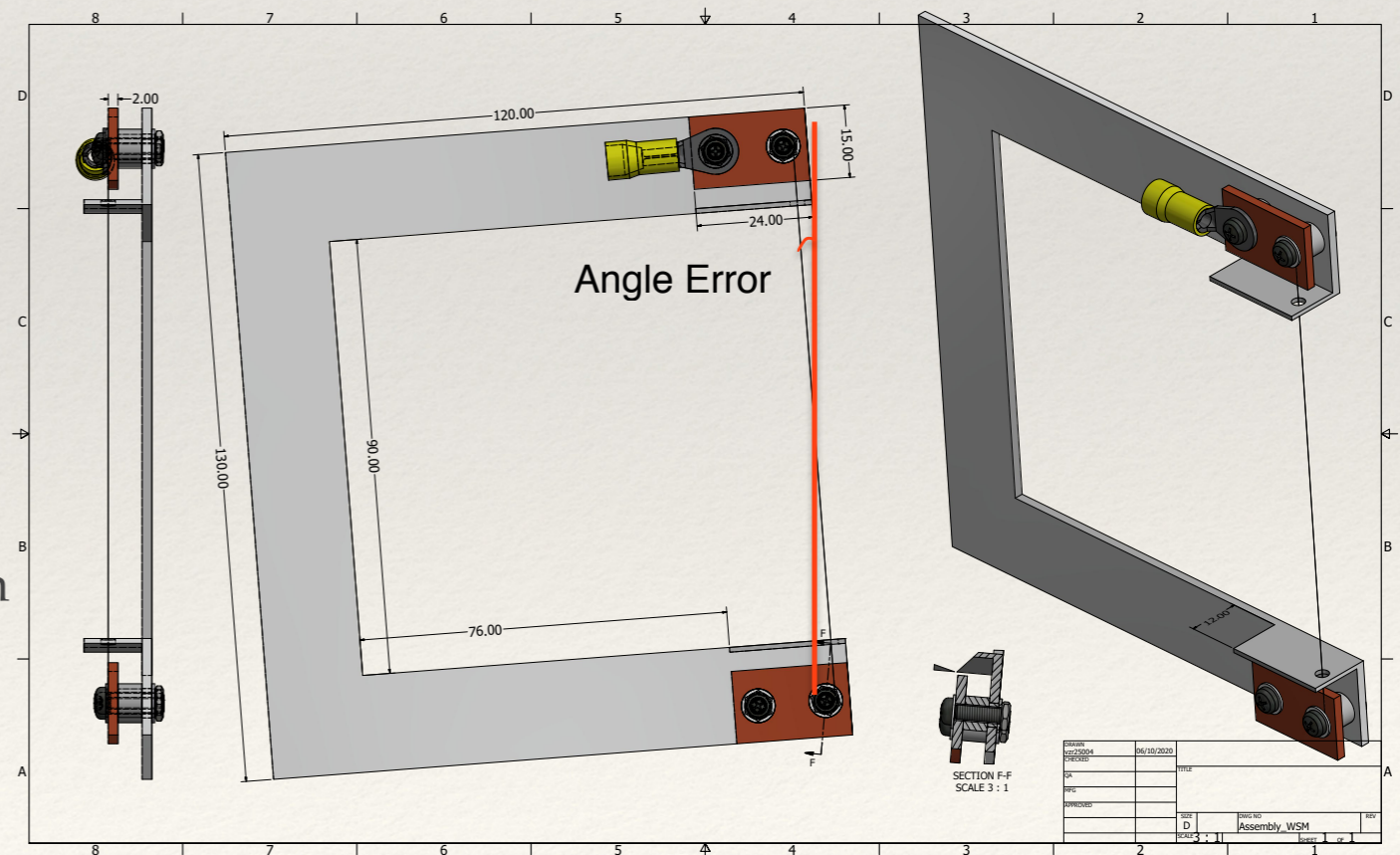
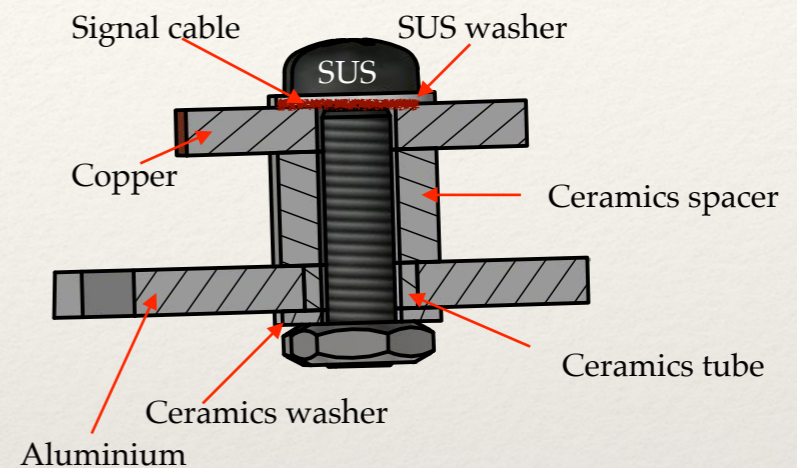
## prototype BPM progress

---

- ❖ Coherent tune shifts due to beam coupling impedance when the BPM is installed at KURNS main ring is currently studied. The results will be presented at next meeting.
- ❖ The screws of prototype BPM has not been changed due to COVID contact cases. This will be done by end of next month.
- ❖ After the modification, BPM features will be remeasured to confirm position sensitivities. After some electrical components test, we will ship the prototype BPM and electronics (RF amplifiers, cables etc) to KURNS. Hopefully it will be by this Autumn.

# WSM progress

- ❖ We decided to purchase  $\phi 10$   $\mu\text{m}$  and  $\phi 30$   $\mu\text{m}$  CNT wires from Hitachi Zosen Cooperation (JP). But they do not provide another sample of CNTs to ISIS.
- ❖ We will have a technical (design) support from ISIS mechanical division officially to design prototype WSM frame. To improve the design properly, we would like to get more information about CNTs.
- ❖ Hitachi Zosen prefers to talk to ISIS mechanical team after we decide to procure. The date of shipping of the CNTs are within 3 month after receipt of written order.
- ❖ Currently I am working on WSM profile simulation with angle errors on the wire, that is to evaluate tolerance of wire positioning.



# CNT wires

## Hitzの垂直配向性CNT「HiTaCa<sup>®</sup>」が、産業に革命を

カーボンナノチューブ ヒタカ

HiTaCa, Hitz vertically aligned CNTs, will achieve a revolution in industry.

### Roll to Roll HiTaCaシート

Roll to Roll HiTaCa sheet

#### HiTaCaシート

HiTaCa sheet



1m長さのシートの製造が可能になりました。  
1 meter wide HiTaCa sheets can be produced.

#### CNT特長 Advantages of CNTs

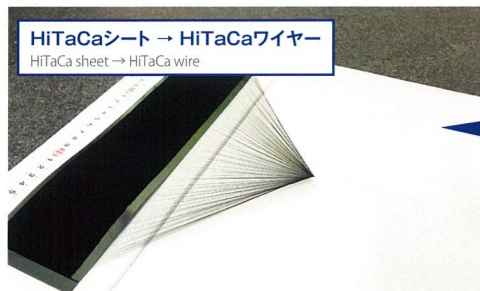
- ・高分子材料並みの軽さ Lightweight comparable to polymer material
- ・機械的強度が高い High mechanical strength
- ・高弾性 High elasticity
- ・高い電気伝導性 High electrical conductivity
- ・高い熱伝導率 High heat conductivity
- ・化学的に安定 Chemical stability

### HiTaCaワイヤー

HiTaCa wire

#### HiTaCaシート → HiTaCaワイヤー

HiTaCa sheet → HiTaCa wire

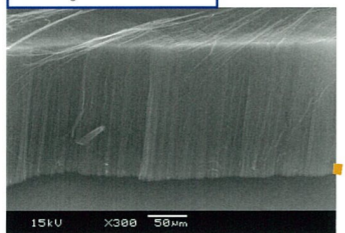


基板からCNTウェブを引き出し、紡ぐことでワイヤーを作製しています。

CNT wires can be made by spinning webs from CNT sheets.

#### HiTaCaシート拡大写真

SEM image



作製可能範囲 Specification

CNT種類	Number of layers	多層 Multilayered
CNT外径	CNT outer diameter	φ10~30nm
CNT長さ	CNT length	50~500μm
本数密度	Tube density	10 <sup>9</sup> ~10 <sup>11</sup> 本/cm <sup>2</sup> 10 <sup>9</sup> ~10 <sup>11</sup> tubes/cm <sup>2</sup>
高密度	Bulk density	10~100mg/cm <sup>3</sup>
純度	Purity	>99%
G/D比	G/D ratio	1~15
電気抵抗率	Electrical resistivity	厚み方向:0.001~0.1Ωcm 面方向:1Ωcm Thickness direction:0.001~0.1Ωcm Across surface:1Ωcm

CNTは炭素でできた直径がナノオーダーのチューブ状繊維です。

CNTs are tubular carbon fibers and their diameters are nanometer order.

Hitzは、均質性に優れた垂直配向性CNT「HiTaCa」を、大面積で製造しています。

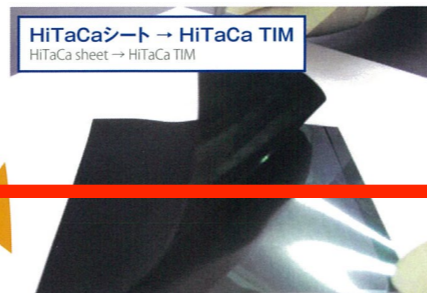
We are manufacturing uniform large-area HiTaCa sheets.

### HiTaCa TIM

HiTaCa TIM

#### HiTaCaシート → HiTaCa TIM

HiTaCa sheet → HiTaCa TIM



基板からCNTを剥離することで、放熱部材として使えます。

CNTs separated from substrates can be used as thermal interface materials.

### HiTaCa応用例

Applications of HiTaCa

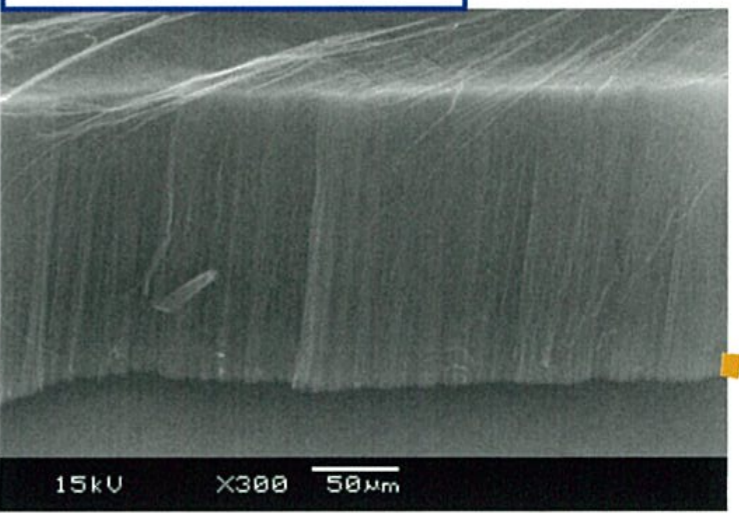


基板からCNTウェブを引き出し、紡ぐことでワイヤーを作製しています。

CNT wires can be made by spinning webs from CNT sheets.

### HiTaCaシート拡大写真

SEM image



作製可能範囲 Specification

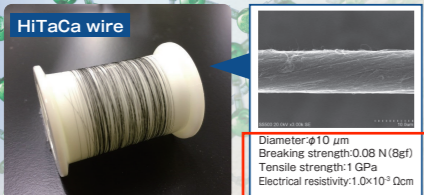
CNT種類	Number of layers	多層 Multilayered
CNT外径	CNT outer diameter	φ10~30nm
CNT長さ	CNT length	50~500μm
本数密度	Tube density	10 <sup>9</sup> ~10 <sup>11</sup> 本/cm <sup>2</sup> 10 <sup>9</sup> ~10 <sup>11</sup> tubes/cm <sup>2</sup>
高密度	Bulk density	10~100mg/cm <sup>3</sup>
純度	Purity	>99%
G/D比	G/D ratio	1~15
電気抵抗率	Electrical resistivity	厚み方向:0.001~0.1Ωcm 面方向:1Ωcm Thickness direction:0.001~0.1Ωcm Across surface:1Ωcm

注) 本掲載データは代表値であり、保証値ではありません。 Note) The figures in this table are representative values and not guaranteed.

# CNT wires

## HiTaCa™ wire

lightweight/little thermal expansion/high tensile strength/flexible



HiTaCa wires are CNT yarns made of vertically aligned CNTs. HiTaCa wires are stronger, lighter and more flexible than conventional metal wires and can be knitted and weaved. Since there is little thermal expansion, HiTaCa wires can be used over a wide temperature range.

Diameter:  $\phi 10 \mu\text{m}$   
 Breaking strength: 0.08 N (8gf)  
 Tensile strength: 1 GPa  
 Electrical resistivity:  $1.0 \times 10^{-3} \Omega\text{cm}$

### Comparison with conventional metal wires

wire	density (g/cm <sup>3</sup> )	tensile strength (GPa)
Cu	8.9	0.3
Al	2.7	0.1
SUS304	7.9	0.6
CNT	1.4	1

Breaking length = Breaking strength / Density

### Applications

- Light wires for wire harnesses and signal lines
- Sensors
- Electromagnetic shield
- Heaters
- Space debris nets

\*Debris nets are used to catch wastes floating in the space.

### Processing examples of HiTaCa wires

Circular knitting fabric from HiTaCa wires

HiTaCa twisted wire with 1 mm diameter

### Low electrical resistance HiTaCa wire

Low electrical resistance HiTaCa wire

Diameter:  $\phi 13.6 \mu\text{m}$   
 Breaking strength: 0.12 N (12gf)  
 Tensile strength: 800 MPa  
 Electrical resistivity:  $4.0 \times 10^{-4} \Omega\text{cm}$

### Relationship between copper coated layer thickness and electric resistivity

HiTaCa wires coated with metal decrease its electric resistivity. We also provide insulator coated wires.

### Cross section of insulator coated wire

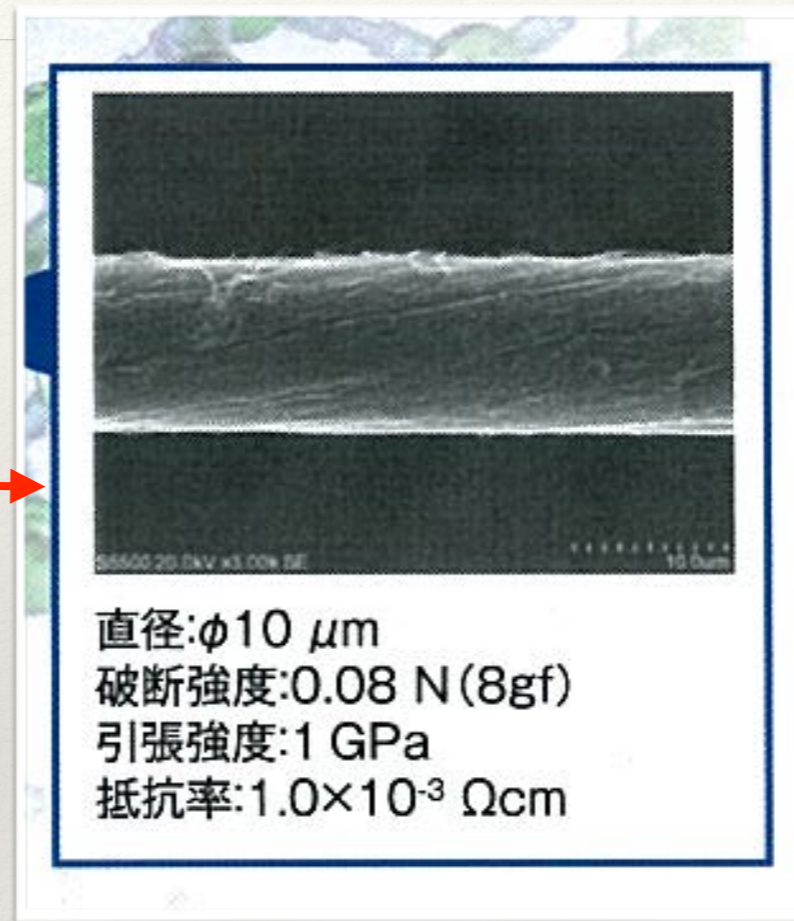
1st layer: Cu  
 2nd layer: Insulator

### HiTaCa wire

Type number	Diameter [ $\mu\text{m}$ ]	Electric resistivity [ $\times 10^{-3} \Omega\text{cm}$ ]	Tensile strength [GPa]
HTC-W-10	10	1~3	1
HTC-W-20	20		

Type number	Diameter [ $\mu\text{m}$ ]	Electric resistivity [ $\times 10^{-4} \Omega\text{cm}$ ]	Tensile strength [GPa]
HTC-W-30	30	1~3	1
HTC-W-50	50		

Note) The figures in this table are representative values and not guaranteed.



Type number	Diameter [ $\mu\text{m}$ ]	Electric resistivity [ $\times 10^{-3} \Omega\text{cm}$ ]	Tensile strength [GPa]
HTC-W-10	10	1~3	1
HTC-W-20	20		