Alternatives for Cu-Be by JX Nippon Mining & Metals

Cu-2%Be C172 → NKT322 C19910 (Cu3Ti-0.2Fe)

Dilute Cu-0.2%Be-Ni → NKC286 C64728 (Cu-Ni-Si)
NKC388 C70252 (Cu-Ni-Si)
### High Strength Hyper Titanium Copper

**“GIGALLOY” NKT322, C19910**

Chemical composition (wt%)

<table>
<thead>
<tr>
<th></th>
<th>Ti</th>
<th>Fe</th>
<th>Cu+Ti</th>
</tr>
</thead>
<tbody>
<tr>
<td>nominal</td>
<td>2.9 – 3.4</td>
<td>0.17 – 0.23</td>
<td>over 99.5</td>
</tr>
</tbody>
</table>

“Environment-recycling is allowed.”
What is Cu-Ti alloy?

Extremely fine Cu-Ti particles in Cu-Ti alloy

JX established the manufacturing processing for Cu-Ti alloy.
**GIGALLOY** **NKT322**

*Higher Strength and Better Formability*

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**NKT322-EH**

90° W Bend Test (Badway)

R/t=0.5

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**C5210HP-EH**

90° W Bend Test (Badway)

R/t=1.0
W-type bend test for formability evaluation
Stress Relaxation Test

\[ y_0 = \frac{2L^2\sigma}{3Et} \]

- \( E \): Modulus of Elasticity
- \( \sigma \): Applied stress (ex. 80\% of yield strength)

Exposing to high temperature

\[ y \text{ (Permanent deflection)} \]

Stress Relaxation (\%) = \( \frac{y}{y_0} \times 100 \)

Stress Remaining (\%) = \( (1 - \frac{y}{y_0}) \times 100 \)
NKT322 provides only 4% of stress relaxation after 1000 hours at 150 degree C.
**Stress Relaxation Resistance of NKT322 at elevated temperatures**

Over 20% of stress remaining should be needed for elevated temperature connectors in Automotive

**Shifted to high stress relaxation resistant copper alloys**
Cu-Ti Alloy “Eco Alloy” in Mobile Phone Connectors

Battery Terminal: NKT322
SIM Connector: NKT322
B to B: NKT322
Ground Contact: NKT322
FPC Connector: NKT322
Jack: NKT322

AFM Spring: C1990-GSH 30um, 40um, 50um

Standard thickness for higher availability:
- 0.08, 0.1, 0.12, 0.15,
- 0.2, 0.25, 0.3 (mm)
Advantages of NKT322 for Cu-Be Alternative

1. **Quality, Property**
   Higher strength and better formability than Cu-Be, and also
   Excellent cyclic fatigue property

2. **Cost**
   NKT322 is competitive to Cu-Be C172, depending on thickness &
   volume.

3. **Delivery**
   Local sourcing through several delivery centers in Far East Asia
   and also Europe & US.

4. **Environment**
   “Green alloy” as environmental recycling-friendly
Alternative Copper Alloys to dilute Cu-Be

High Strength Titanium Copper “GIGALLOY”

Cu-2%Be C172 → NKT322 C19910 (Cu-3Ti-0.2Fe)

Dilute Cu-0.2%Be-Ni → NKC286 C64728 (Cu-Ni-Si)

NKC388 C70252 (Cu-Ni-Si)
Corson Alloy  Cu- (Ni, Co) - Si

- Dr. M. G. Corson invented Corson alloy in 1927.
- Cu − (1.5-4%) Ni, Co − (0.4-1%) Si
  \[ \text{Ni, Co / Si} \div 2/1 \text{ (molar ratio)} \]
- Precipitation of Ni$_2$Si or Co$_2$Si compound
- High strength and High conductivity
- Many kinds of Corson alloys are developed
What is “Corson Alloy”? 

In 1929, Dr. M.G. Corson developed Cu- Silicide alloy such as Cu-Ni-Si or Cu-Co-Si. Since then, the type of alloy is called “Corson alloy” after him.
# High Strength – High Conductivity

**NKC286(C64728)**

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**Chemical composition**

<table>
<thead>
<tr>
<th></th>
<th>Cu</th>
<th>Ni</th>
<th>Si</th>
<th>Sn</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal</td>
<td>Bal.</td>
<td>2.8</td>
<td>0.6</td>
<td>0.5</td>
<td>0.4</td>
</tr>
</tbody>
</table>

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*The Future of Energy, Resources and Materials*

*JX Nippon Mining & Metals Corporation*
# Highest Strength Corson NKC388 (C70252)

## Chemical composition

<table>
<thead>
<tr>
<th></th>
<th>Cu</th>
<th>Ni</th>
<th>Si</th>
<th>Mg</th>
<th>Mn</th>
</tr>
</thead>
<tbody>
<tr>
<td>nominal</td>
<td>bal.</td>
<td>3.4 ~ 4.2</td>
<td>0.7 ~ 1.0</td>
<td>0.05 ~ 0.3</td>
<td>0.11 ~ 0.5</td>
</tr>
</tbody>
</table>

## Temper

<table>
<thead>
<tr>
<th></th>
<th>Tensile (MPa)</th>
<th>0.2% yield (MPa)</th>
<th>Minimum Bend Ratio / thickness (Bad way)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH</td>
<td>940</td>
<td>910</td>
<td>1.0</td>
</tr>
<tr>
<td>ESH</td>
<td>980</td>
<td>950</td>
<td>3.0</td>
</tr>
</tbody>
</table>
Strength and Conductivity of Corson Alloys and Dilute Cu-Be Alloys

![Graph showing the strength and conductivity of Corson Alloys and Dilute Cu-Be Alloys. The graph plots yield strength (MPa) against electronic conductivity (%IACS). Two alloys are highlighted: NKC388(C70252) and NKC286(C64728).]
Strength and Bend formability of Corson Alloys and Dilute Cu-Be Alloys

![Diagram showing load and yield strength relationship with minimum bend radius/thickness for Corson Alloys (NKC388(C70252)) and Dilute Cu-Be (NKC286(C64728)) alloys.]

- **NKC388(C70252)**
- **NKC286(C64728)**

Yield strength (MPa)

Minimum bend radius/Thickness (Transverse direction)

R = t

R/t = 1.0

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Summary

✓ Very high strength Cu-Ti alloy, NKT322 has been already commercialized for alternative to Cu-Be C172.

✓ High strength & high conductivity Corson alloys have been already commercialized for alternative to Cu-dilute Be alloys.