

# **CFRP** precision molding dies for mass production ~ Newly developed low thermal expansion cast alloys ~

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# Results and discussion

## A) Grain refinement and randomization



Macrostructure images obtained from (a) the as-cast and (b) the cryogenic treated and annealed specimens in Fe-32%Ni-5%Co alloys



Coarse columnar grains were formed in the as-cast Fe-32%Ni-5%Co specimen, whereas the equiaxed fine grains with random texture could be obtained by the cryogenic treatment and annealing.

XRD profiles for the as-cast and the cryogenic treated and annealed specimens in Fe-32%Ni-5%Co alloys.

### **Optimization of Ni and Co contents** B)



Optical microscope images of Fe-x%Ni invar alloys after cryogenic treatment at 77 K.



Optical microscope images of Fe-*x*%Ni-15%Co kovar alloys after cryogenic treatment at 77 K.

Optimum compositions were determined by precise control of Ni contents to obtain LTE alloys with equivalent coefficient of thermal expansion (CTE) of CFRP.

### Improvement of mechanical properties C)



comparison, those of the conventional alloys are also shown.



Mechanical properties of the developed invar and kovar alloys. For comparison, those of the conventional alloys and forged alloys are also shown.

- Novel LTE cast alloys with equivalent CTE of CFRP were developed by precise control of Ni content, which would enable high precision molding.
- The mechanical properties could be drastically 2. improved by the cryogenic treatment and annealing, while maintaining the low thermal expansion.



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