

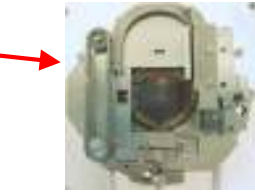


# Combinatorial Investigation of Metallic Alloy Systems

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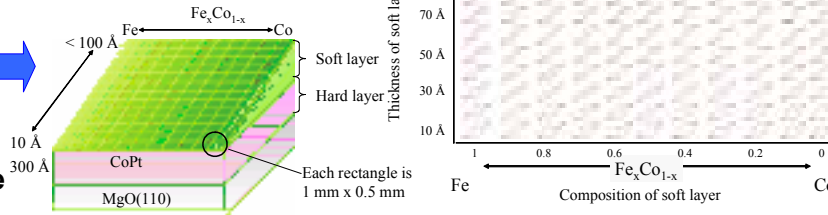
## Combinatorial E-beam evaporation chamber



Combinatorial flange

## Systematic investigation of exchange coupling: $Fe_xCo_{1-x}/CoPt$

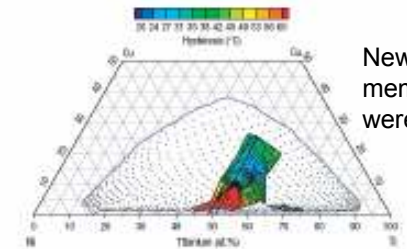
### Design of library



Systematic change in exchange coupling behavior is observed.

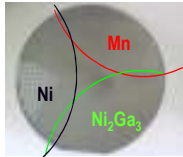
## Combinatorial search of thermoelastic shape-memory alloys

Martensite regions and thermal hysteresis in Ni-Ti-Cu



New shape memory alloys were discovered

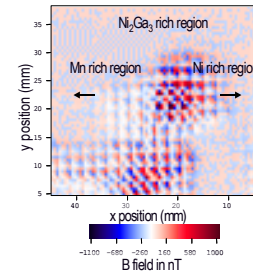
## Combinatorial UHV sputtering for composition spread deposition



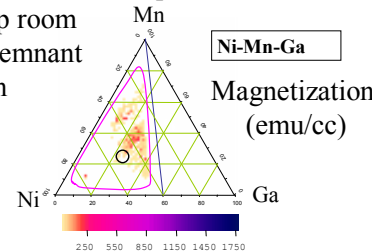
Example: Ni-Mn-Ga  
Targets: Ni, Mn,  $Ni_2Ga_3$   
Substrate: Si (3 inch)  
Thickness  $\approx 2500 \text{ \AA}$

Co-sputtering System  
( $P_{base} \sim 1 \times 10^{-9}$  Torr)

## Rapid Characterization of Composition Spreads



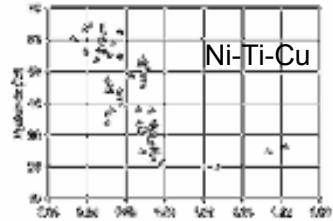
Scanning SQUID microscope is used to map room temperature remnant magnetization



Cantilever libraries are used to map the regions that transform martensitically

I. Takeuchi *et al.*  
Nature Mater. **2**, 180 (2003)

## Hysteresis width vs lattice parameters

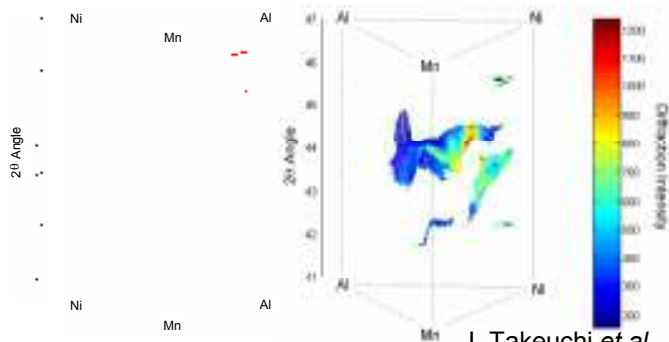


The new theory of martensite was verified

(calculated from lattice parameters)

J. Cui *et al.*  
Nature Mater. **3**, 286 (2006)

## 3-D mapping of Ni-Mn-Al X-Ray Data



Microdiffraction of composition spreads is visualized using 3-D schemes

I. Takeuchi *et al.*  
Rev. Sci. Instr. **76**, 062223 (2005)

## Summary:

- We use combinatorial e-beam evaporation and UHV sputtering chambers for metal systems.
- As high-throughput characterizations techniques, we developed magneto optical Kerr effect (MOKE), room temperature scanning SQUID for magnetic properties, and cantilever libraries for shape memory effect.
- We found new thermoelastic shape-memory alloys with extremely small hysteresis width using combinatorial screening.
- Data management and data visualization techniques allow us to better organize and visualize large amount of data generated.

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