

# Controlling Epitaxial Self-assembled Nanomagnets

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## Motivation:

Strain-driven self-assembly nanostructures:

- \*One monolayer wetting followed by 3-D growth
- \*Fabricate large arrays in a fast, low cost process

**Challenge: How to control spatial position? Shape?**  
 —Modify the substrates!

## Experimental Approaches:

Molecular-beam epitaxy (MBE), AFM/MFM and MOKE

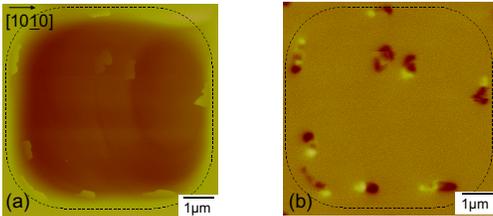
## Conclusions:

- We can indeed control the *shape*, *alignment* and *magnetic anisotropy* of the self-assembled nanomagnets.
- The controlling can be realized by either lithographically pre-patterning the substrates or using a substrate with different symmetry.
- A promising direction to fabricate complex and functional nanostructures.

## 1. Lithographically patterned substrates

Co on Ru(0001) substrate with **square** patterns

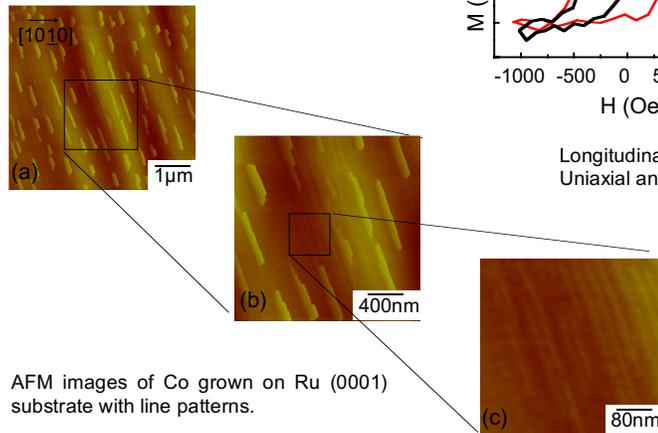
- \* Nanodots decorate the edges
- \* Magnetic domains follow the pattern



(a) AFM and (b) MFM images of Co dots grown on Ru (0001) substrate with square patterns.

Co on Ru(0001) substrate with **line** patterns

- \* Stripes and nanowires
- \* Magnetic uniaxial anisotropy



AFM images of Co grown on Ru (0001) substrate with line patterns.

## 2. Substrates with different symmetry

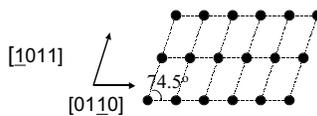
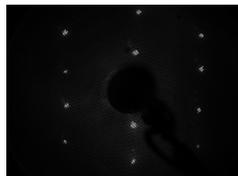
Fe on Ru(1011) substrate

Elongated nanodots are formed due to asymmetric diffusion, compared with hexagonal dots on (0001) surface

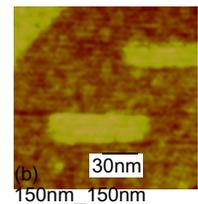
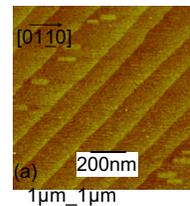
Nanomagnets shape can be controlled by using different symmetry substrates.

LEED pattern of Ru (1011) substrate.

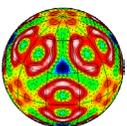
E=113.6 eV



Lattice structure of Ru (1011) surface.



AFM images of Fe nanodots grown on Ru (1011) substrate.



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