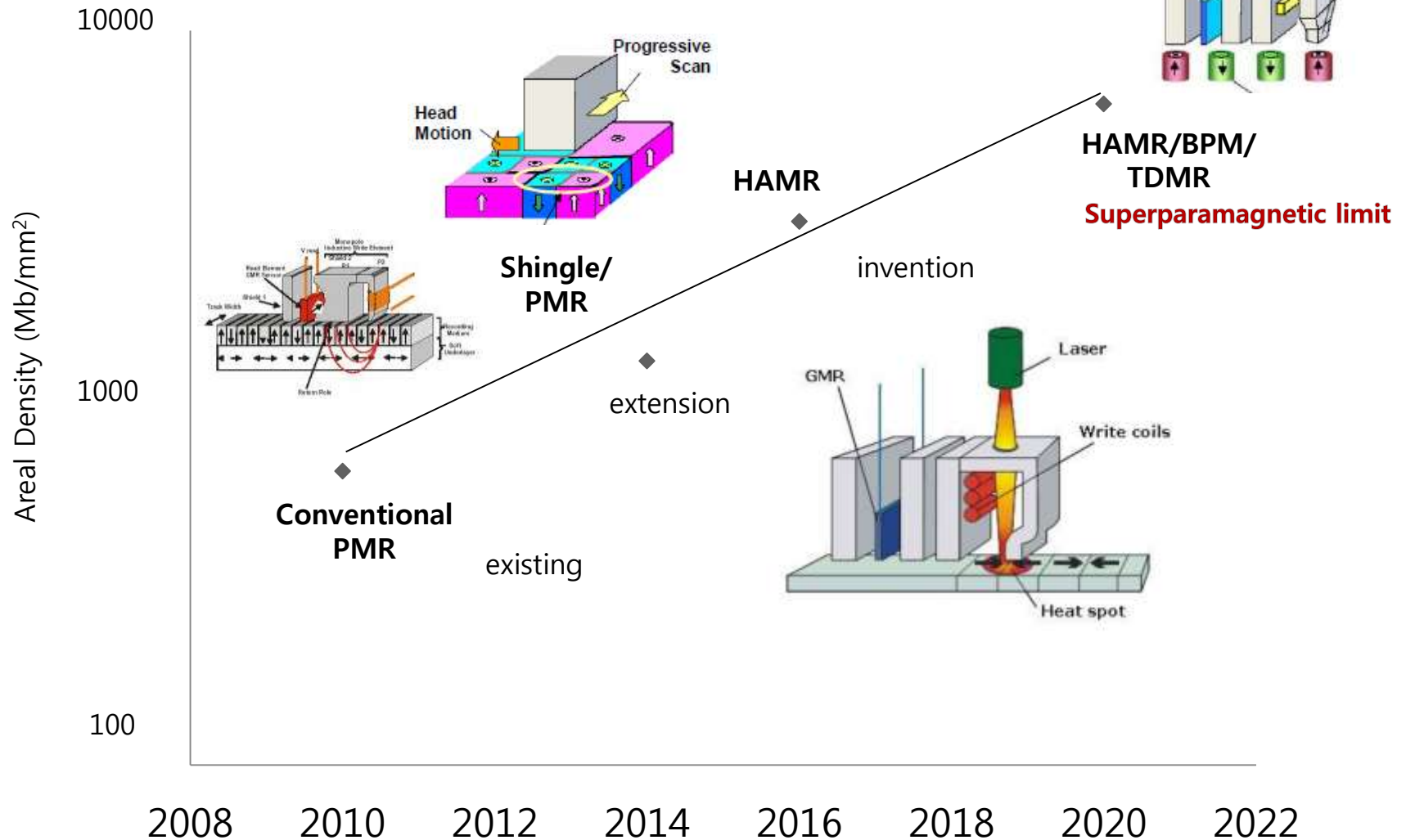


Heat Assisted Magnetic Recording

History

HDD's areal density growth



History

1950 – Engineers filed a patent which describes using heat conjunction with a magnetic field to record data.

1980 – A class of mass storage device called the magneto-optical drive became commercially available which used the same technique for writing data to a disk.

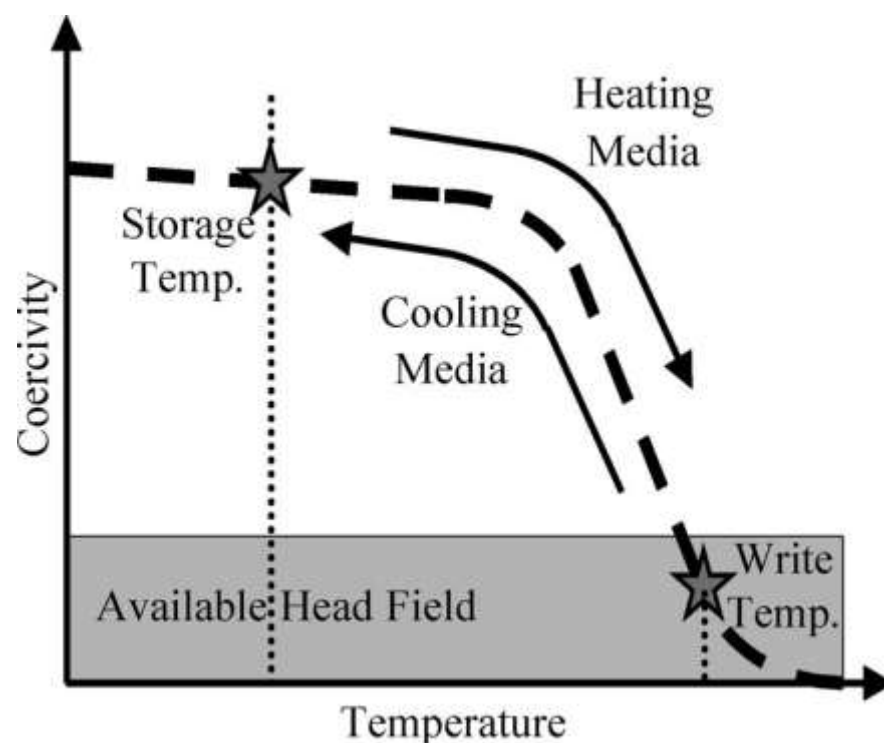
1988 – A single 5.25” magnetic disk had a capacity of around 100MB.

2006 – HAMR was developed in Fujitsu, Japan so that it could achieve one tB per square inch.

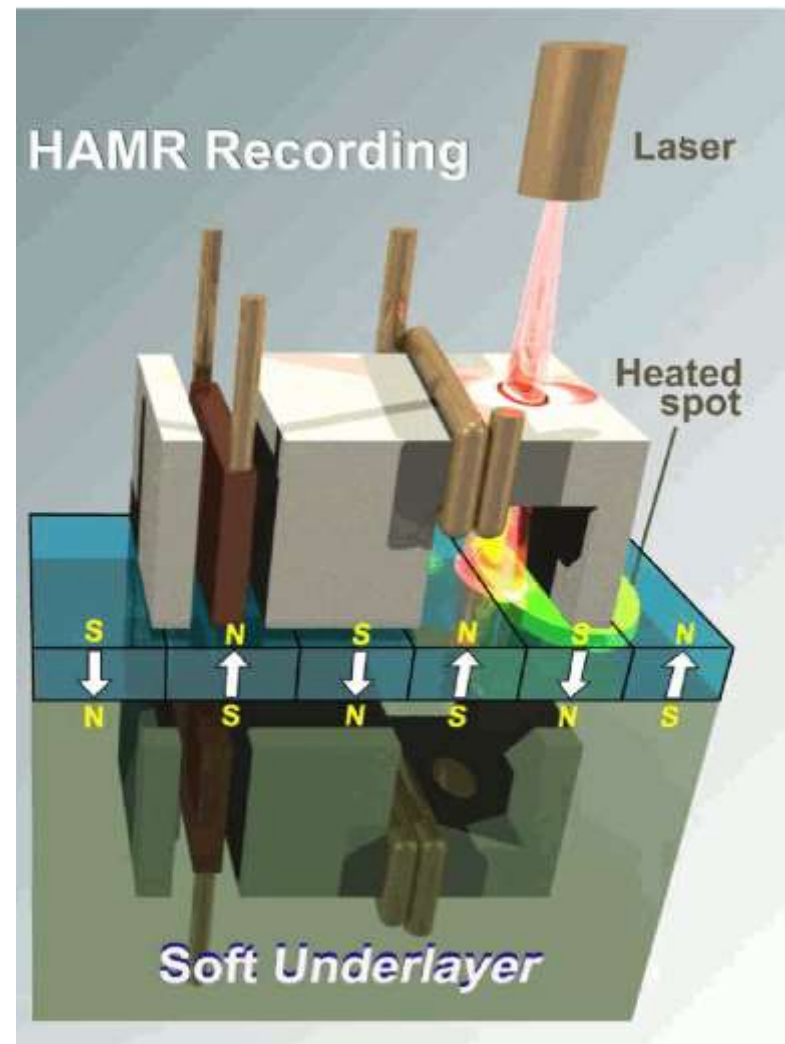
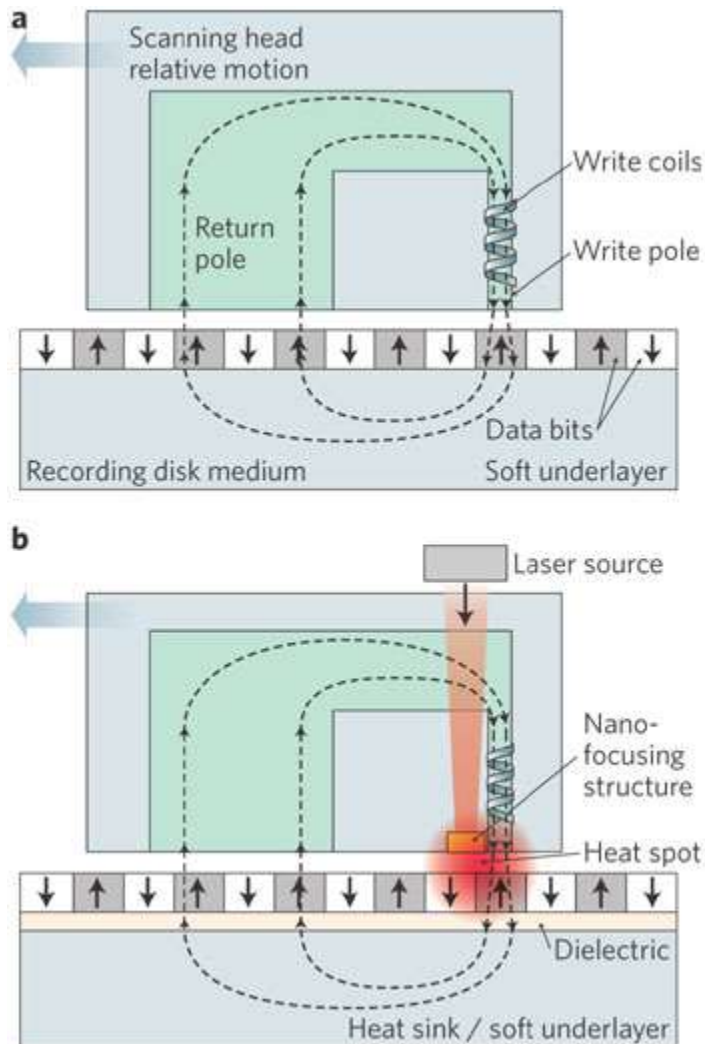
2012 – Seagate created the first drive maker to achieve a storage density of 1tB per square inch.

Principle

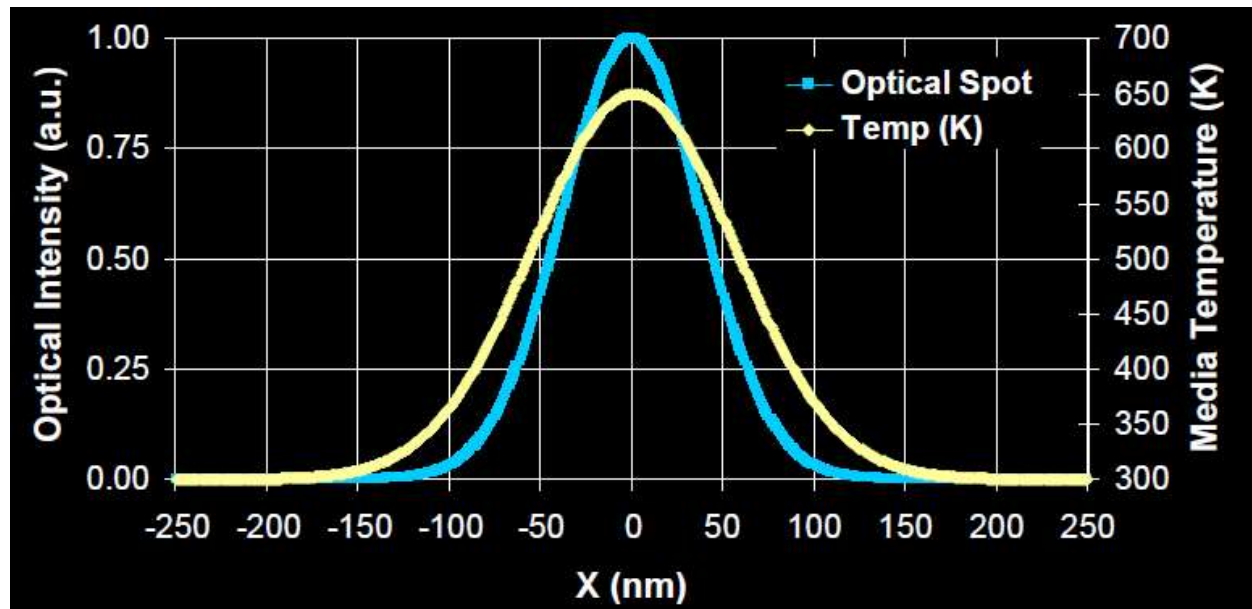
- Coercivity becomes lower when temperature increases
- Writing at high temperature
- Storage at low temperature
- Rapid heating & cooling are needed



Principle

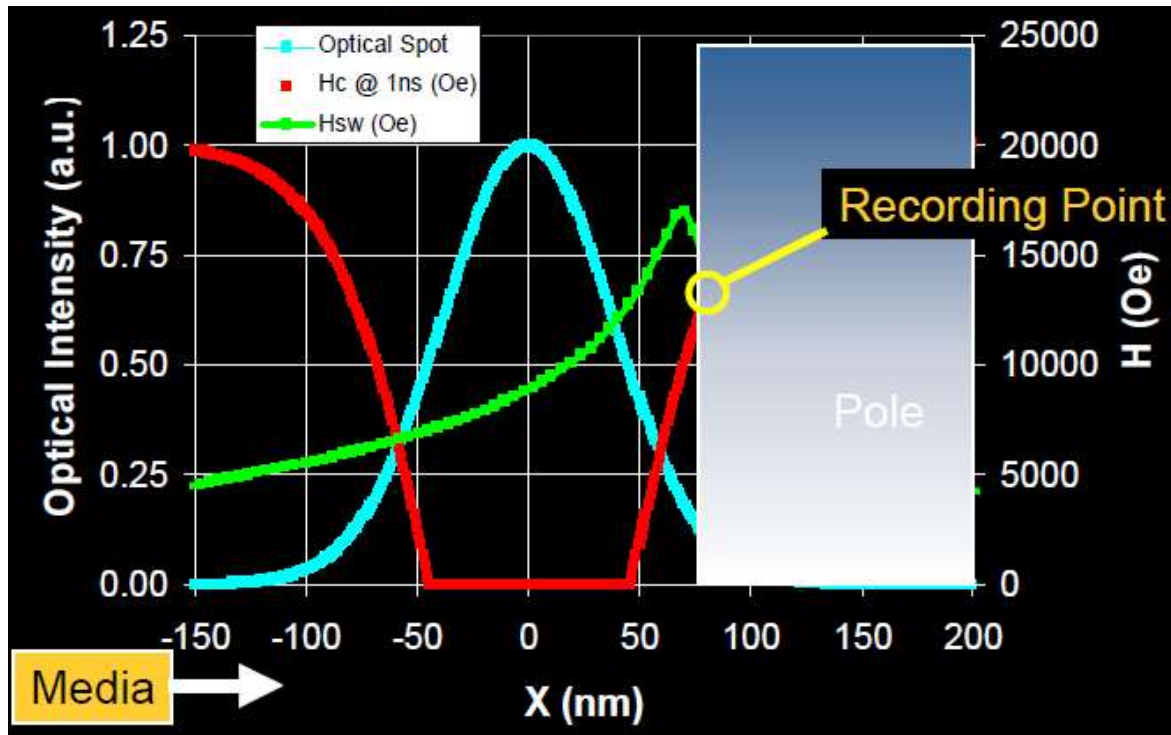


Discussion



- Lateral thermal transport should be blocked
- Rapid vertical thermal transport is necessary

Discussion



- Discordance of optical spot and recording pole
→ Optimization

Discussion

Reducing optical spot size

1. Light condenser : solid immersion lens(SIL), solid immersion mirror(SIM)
2. Near field transducer : overcome the diffraction limit

Planar Solid Immersion Mirror(PSIM)

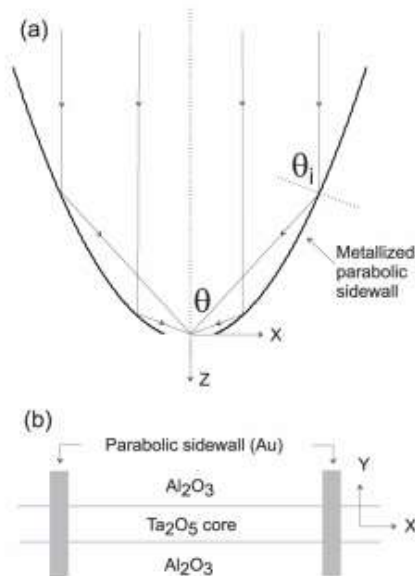
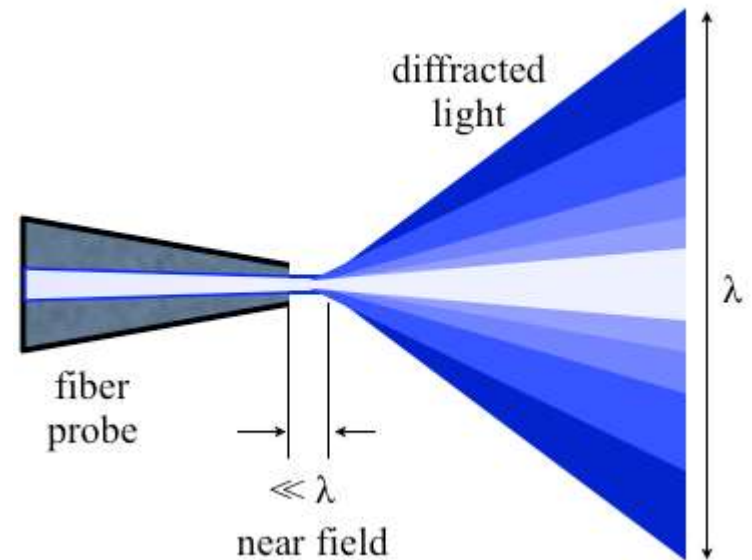
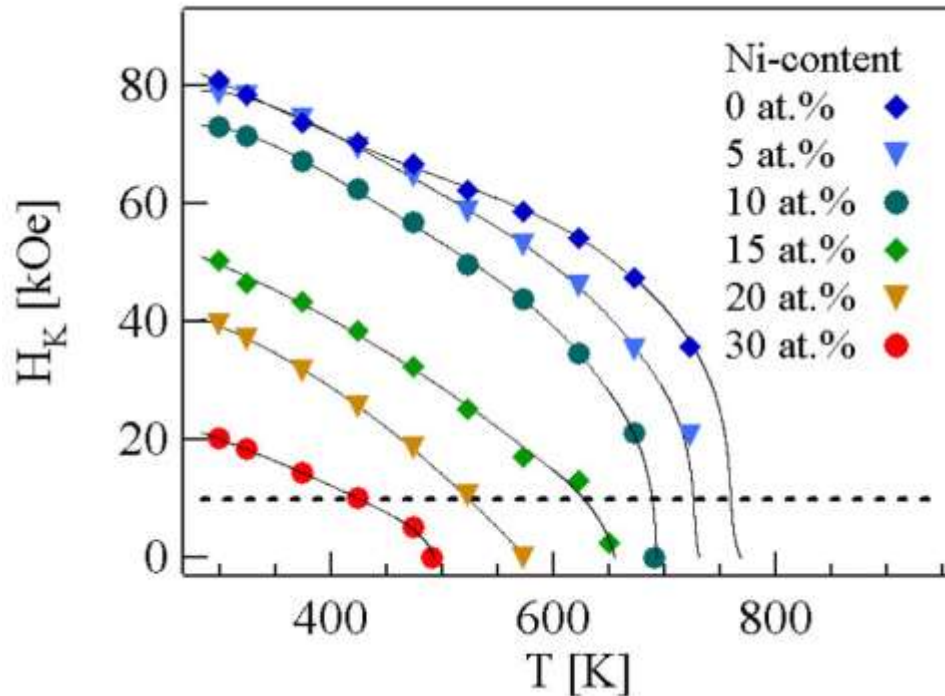


Fig. 2. Focusing of a planar solid immersion mirror. A two-dimensional parabolic mirror (a) is fabricated by cutting through an optical planar waveguide (b) and metallization on the sidewall. Light, launched into the waveguide by grating coupler, propagates in the waveguide, enters into the solid immersion mirror, and is brought to focus. XYZ is a right-handed rectangular Cartesian coordinate system with the z-axis along the optical axis of the mirror. (x, z) = (0, 0) is at the geometrical focal point of the parabolic mirror.



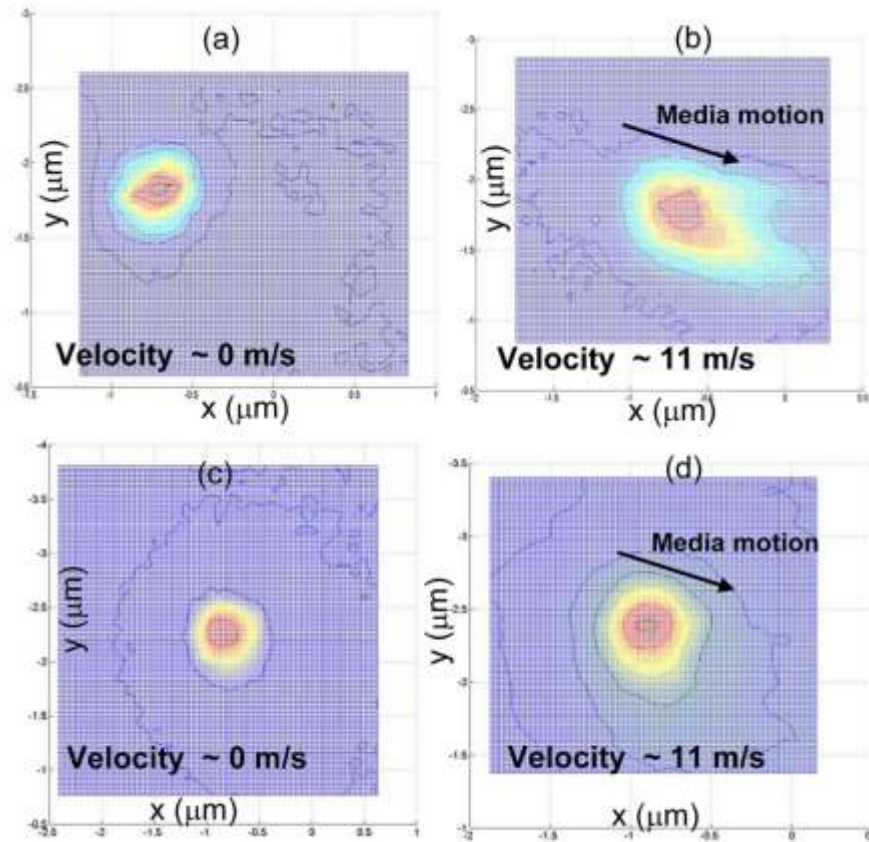
Near field Optics

Discussion



- **Medium material** is important factor
- Curie temperature is tunable by doping

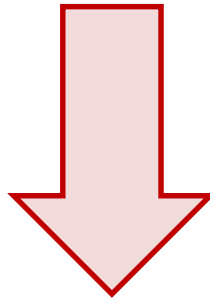
Discussion



- Rotation of disk spreads heat
- **Good heat sink layer** is needed

Conclusion

- High temperature may cause pole tip protrusion, media deformation and damage to the lubricants
- Optical focusing is challenging
- Alignment between the thermal spot and the head field has to be obtained



+ Bit patterned media

Areal density of $\sim 100 \text{ Tb/in}^2$