

Nanophase Materials

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General areas of research and collaborative interest

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Powder metallurgy using nanophase materials.

- * **low-temperature sintering.**
- * **superior hardness.**
- * **preferred grain orientation.**

Nanophase ZnS, CdS phosphors.

- * **tailor properties by changing particle size.**
- * **tailor properties by changing coating and sensitizer.**

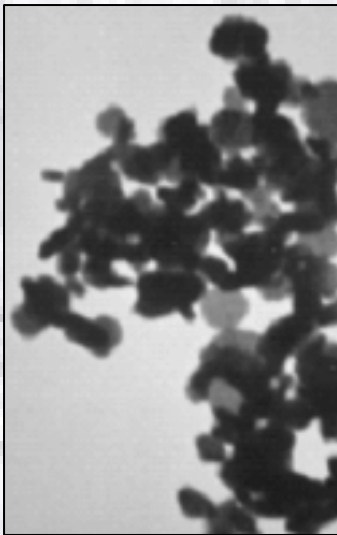
Nanostructured electrodes.

- * **improved energy storage.**
- * **improved kinetics.**

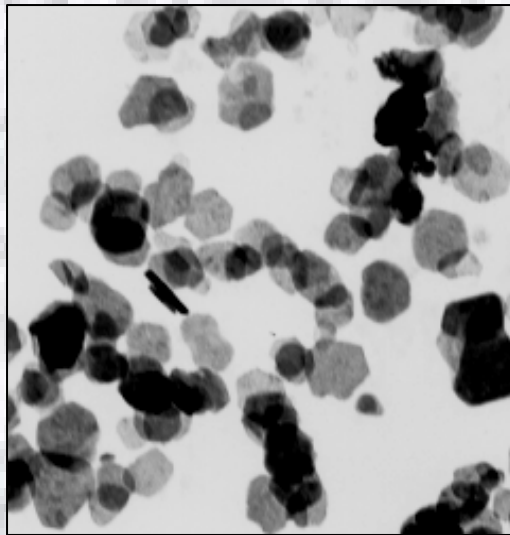
Powder metallurgy using nanophase materials.

- We developed a process to make Fe, Co, Ni, and Cu nanodisks
(Nanodisks: USP 6,156,428)

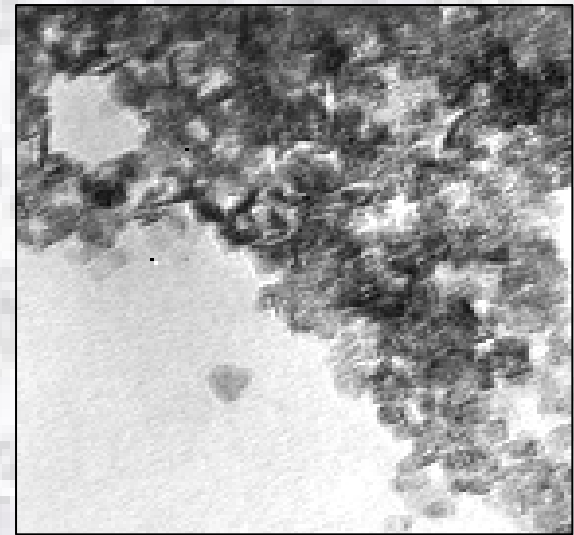
Fe: 200 x 30 nm



Co: 100 x 15 nm

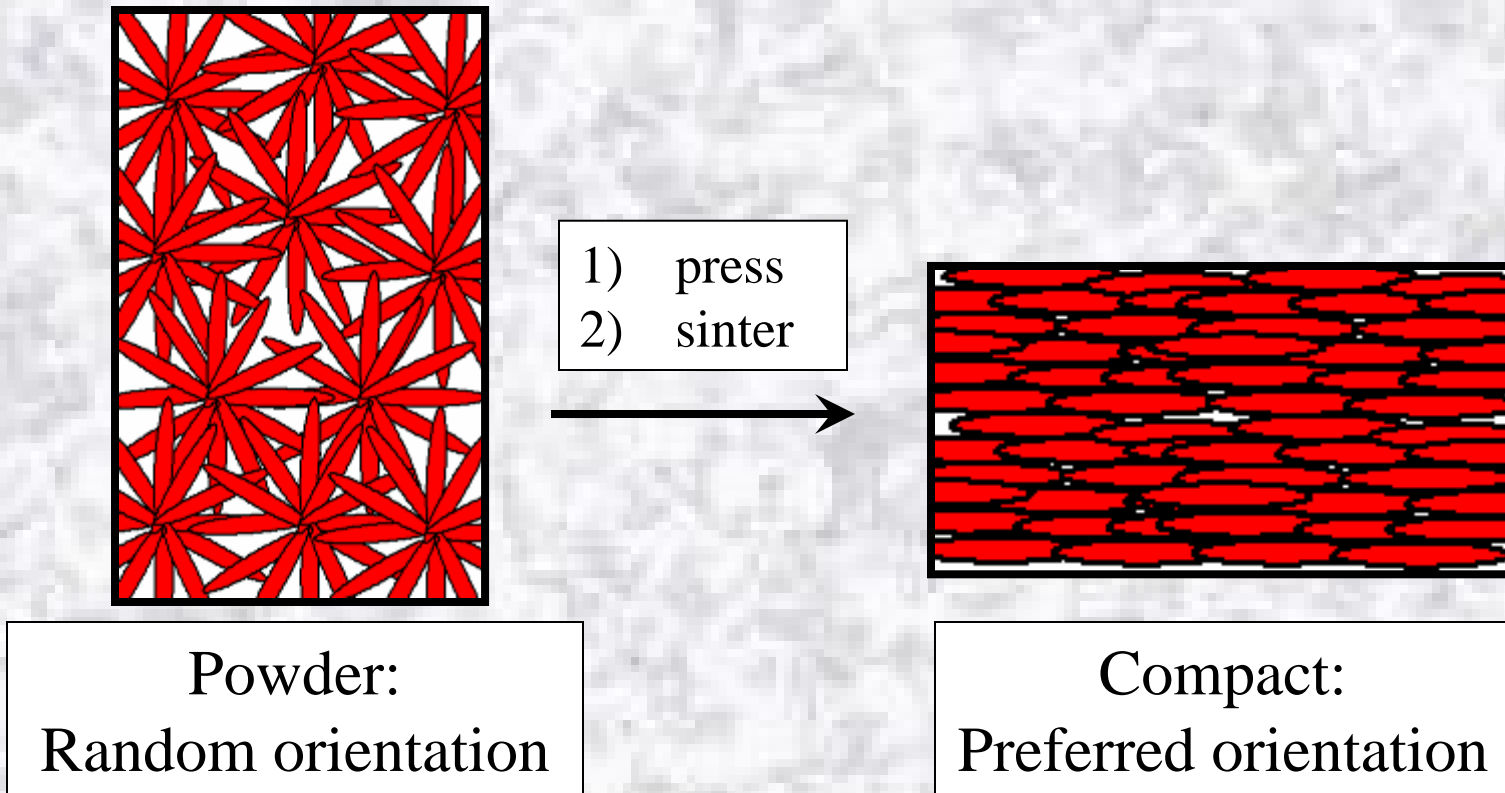


Ni: 20 x 1 nm



Powder metallurgy using nanophase materials.

- Compacting the powder gives an object that has preferred grain orientation, and which can be sintered at relatively low temperature.
(Nanostructured metal compacts: USP 6,136,061)



Powder metallurgy using nanophase materials.

Next step...

Make nanograin cemented carbides (i.e., WC/Co).

- (1) Combine ns-WO₃, ns-Co, C (nanotube).
- (2) Reduce/carburize to convert ns-WO₃ to ns-WC.
- (3) Shape and sinter

Nanophase ZnS and CdS.

- (1) We developed a new high yield, scalable synthesis of nanoscale ZnS and CdS.
- (2) One potential application is for use in IR optical devices. (e.g., shape and sinter the ns-ZnS powder to form optical component.)
- (3) Perhaps the most promising application is the use of these materials as nanoscale phosphors. These may be particularly useful solid-state lighting devices.

Nanophase phosphors.

- (1) ZnS and CdS are useful phosphors. Usually made by high-temperature methods. Gives large particles.
- (2) Nanoscale phosphors may be desirable for some applications. We are currently investigating the use of nanoscale ZnS as a phosphor.
- (3) One promising approach is to modify the ns-ZnS surface with a bifunctional ligand. One functional group of the ligand selectively binds to the ns-ZnS, the other to a sensitizer.
- (4) We plan to tailor properties by changing particle size, ligand, and sensitizer.

Nanostructured electrodes.

- (1) The performance of capacitors, batteries, etc. depends on electrode structure.
- (2) Nanostructured electrodes may improve performance (e.g., improved energy storage capacity, improved kinetics.)
- (3) My main interest is in ultracapacitors and pseudocapacitors.
- (4) I plan to begin experimental work in this area early this year.



Image from: http://tiki.oneworld.net/questions/tiki_questions2.gif