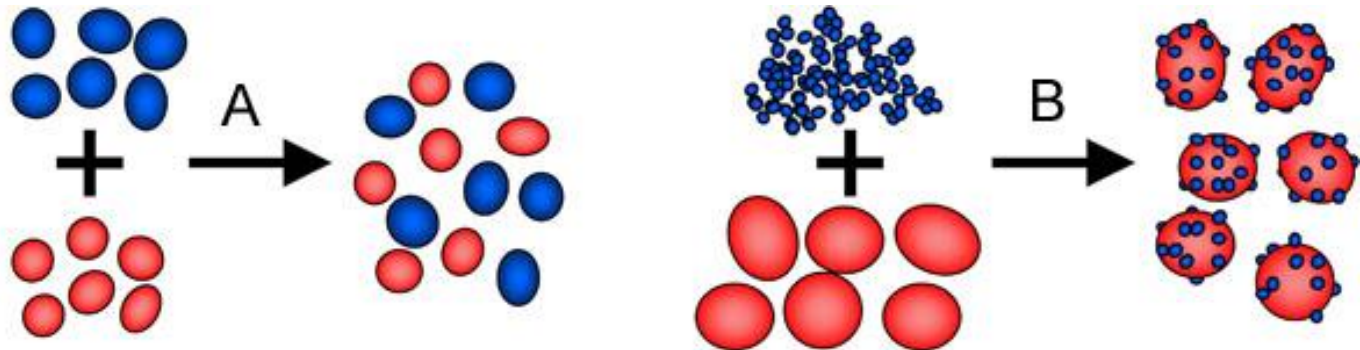


## Lecture # 5

# POWDER METALLURGY

# Alloying Methods

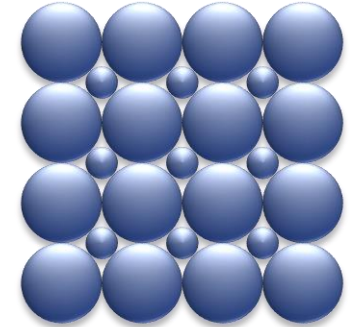


Dr. Mohammed Gamil

# Powder Blending and Mixing

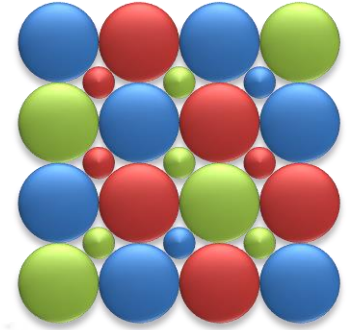
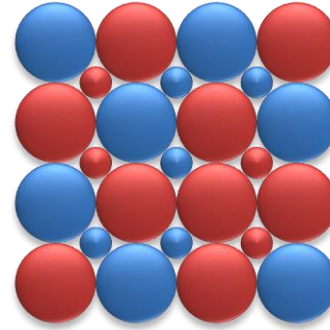
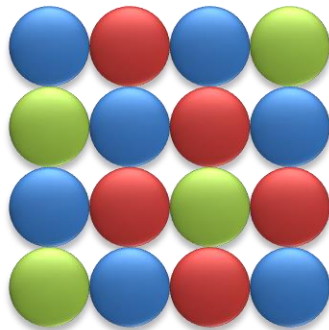
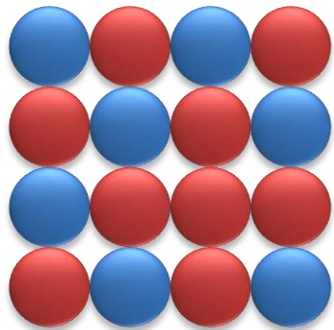
- Blending

Combining powders of the **same** material but possibly different particle sizes.



- Mixing

Combining powders of **different** materials.

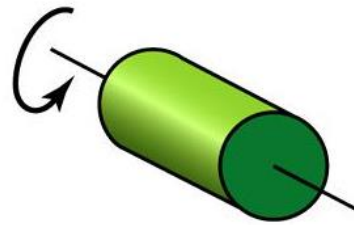


# Powder Blending and Mixing (Cont.)

- The majority of **powders** are mixed with **other powders**, **binders**, and **lubricants** to achieve the desired characteristics in the finished product.
- Unique composites can be produced by blending and mixing.
- Blending or mixing operations can be done either wet or dry.

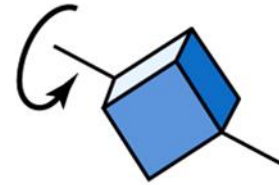


# Blending and Mixing Devices



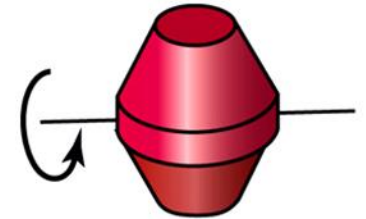
(a)

Rotating drum  
mixer



(b)

Cubic  
mixer



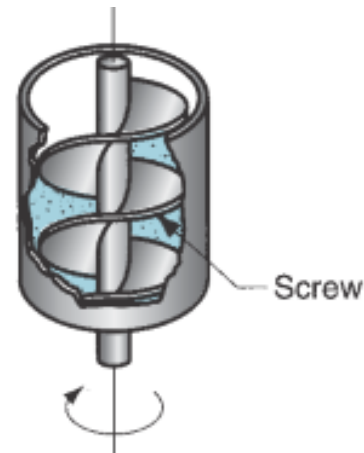
(c)

Rotating double  
cone mixer

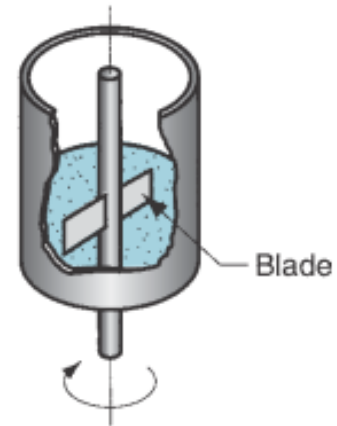


(d)

V  
mixer



Screw mixer



Blade mixer



# Additives

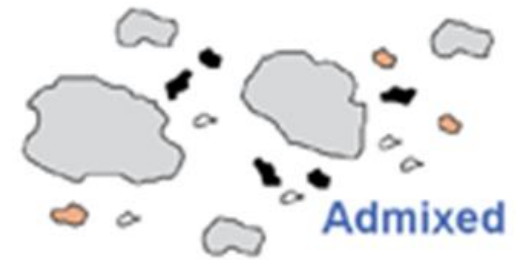
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- **Lubricants**, such as stearates of zinc and aluminum, in small amounts to reduce friction between particles and at the die wall during compaction.
- **Binders**, which are required in some cases to achieve adequate strength in the pressed but unsintered parts
- **deflocculants**, which inhibit agglomeration of powders for better flow characteristics during subsequent processing.

# Alloying Methods

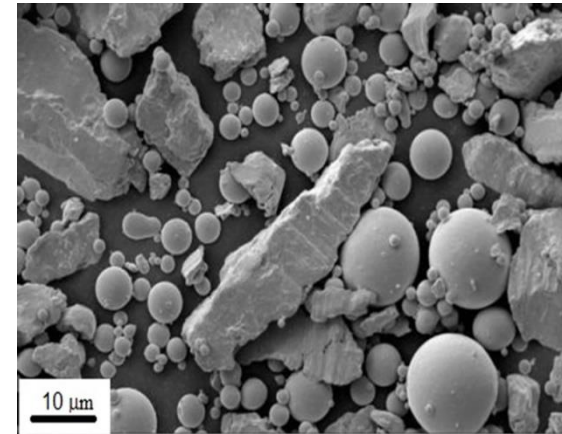
## 1. Admixed

- Elemental alloying powders (copper, nickel, graphite) are added to Iron (base powder)



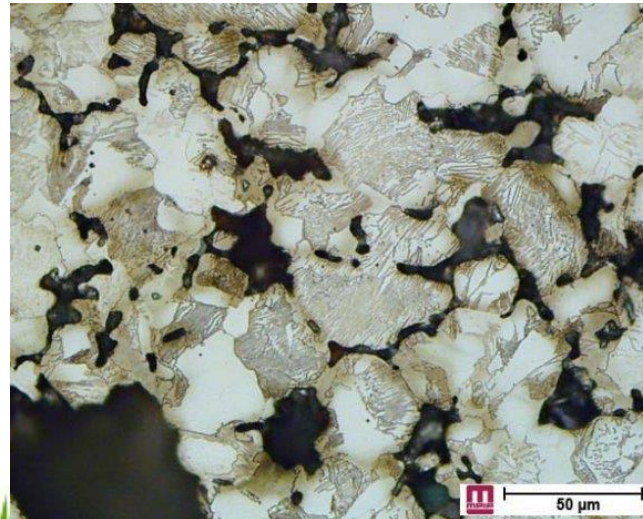
- Example

- Fe + 2 wt% Cu + 0.8 wt% graphite + 0.75 wt% lubricant (FC-0208)
- Fe + 2 wt% Cu + 2 wt% Ni + 0.6 wt% graphite + 0.75 wt% lubricant (FN-0205)



# Alloying Methods (Cont.)

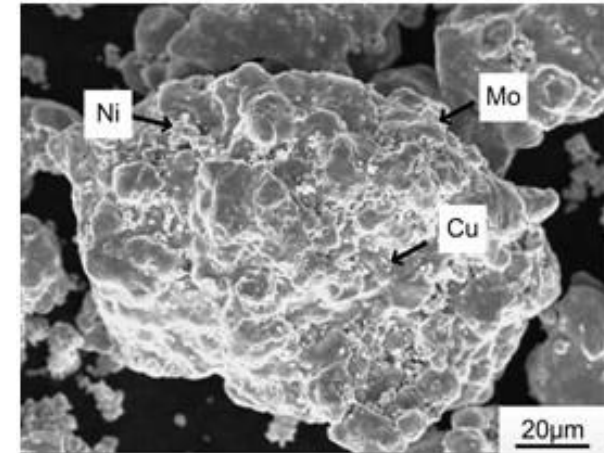
- Tendency to dust and segregate.
- Different specific gravities and particle sizes (Lubricants and graphite have low specific gravities and small particle sizes).
- Heterogeneous microstructure occurs.
- Non-uniform apparent hardness results.



# Alloying Methods (Cont.)

## 2. Diffusion alloyed

- Composed of two or more elements with alloying additives that are **diffusion-bonded** to the base powder during the powder manufacturing process.
- These powders produce a **heterogeneous** microstructure with good dimensional control and excellent as-sintered mechanical properties.
- Exhibit excellent properties.
- Unique method of producing ferrous powders alloyed with various combinations of **nickel**, **copper** and/or **molybdenum**





# Alloying Methods (Cont.)

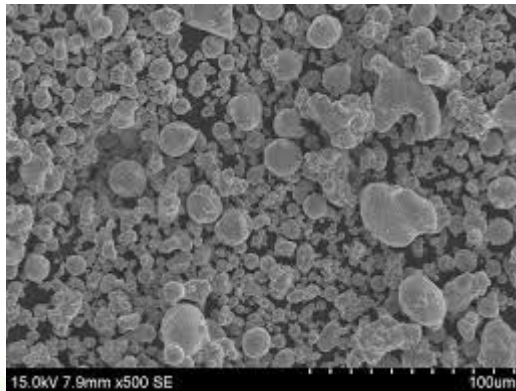
## 3. Prealloyed

- Atomized from alloyed furnace melts such that each powder particle has the same nominal composition throughout.
- Prealloyed powders yield homogeneous phase in the microstructure.
- Low compressibility
- High compaction pressure is required with Molybdenum.
- Respond well to heat treatment.
- Example: Nickel-Molybdenum prealloyed powder



# Alloying Methods (Cont.)

- Compressibility is reduced compared with admixed and diffusion-alloyed powders.
- Homogeneous microstructure results.
- Uniform apparent hardness results.
- Alloying does not depend on diffusion process.
- Alloying is done while metal is in molten state.



Pre-alloyed powders for diamond tools  
Soft magnetic powders for powder  
cores FeSiCr soft magnetic powder for  
SMD/DIP Stainless steel powder

# Alloying Methods (Cont.)

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## Prealloyed

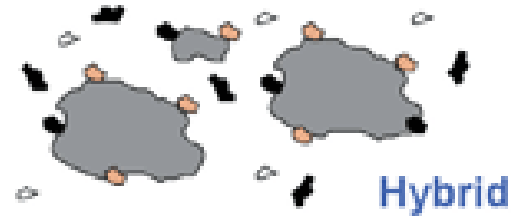
Each particle is an alloy comprised of the desired chemical composition

- Used for alloys that cannot be formulated by mixing elemental powders.
- Common prealloyed powders.
  - Stainless steels
  - Certain copper alloys
  - High speed steel

# Alloying Methods (Cont.)

## 4. Hybrid

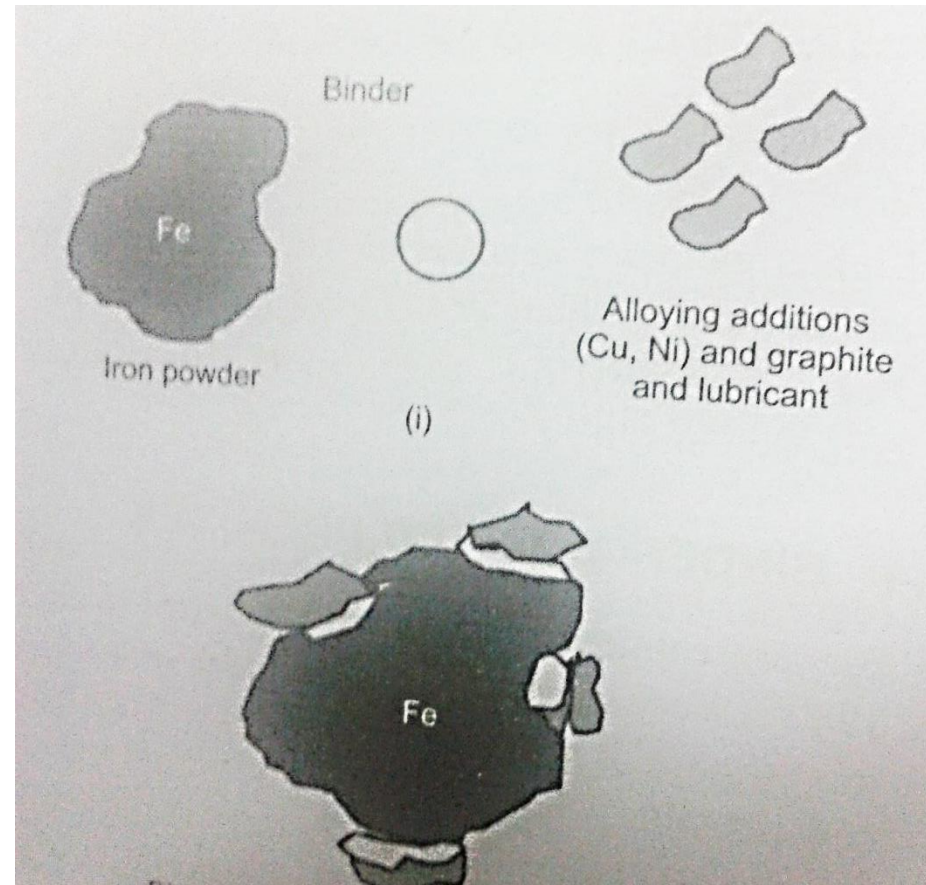
- **Pre-alloyed** or **diffusion-alloyed** powder with elemental or ferroalloy additions **admixed** to produce the desired composition.
- Heterogeneous microstructure results.





# Binder treated premixes

- Very special glue had to be created for this purpose.
- The concept is illustrated in the figure
- Reduces dusting and segregations.
- Improve material flow rates.
- No negative impact on compaction and sintering.



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Thank You!  
😊

