Mechanical Alloying
MA

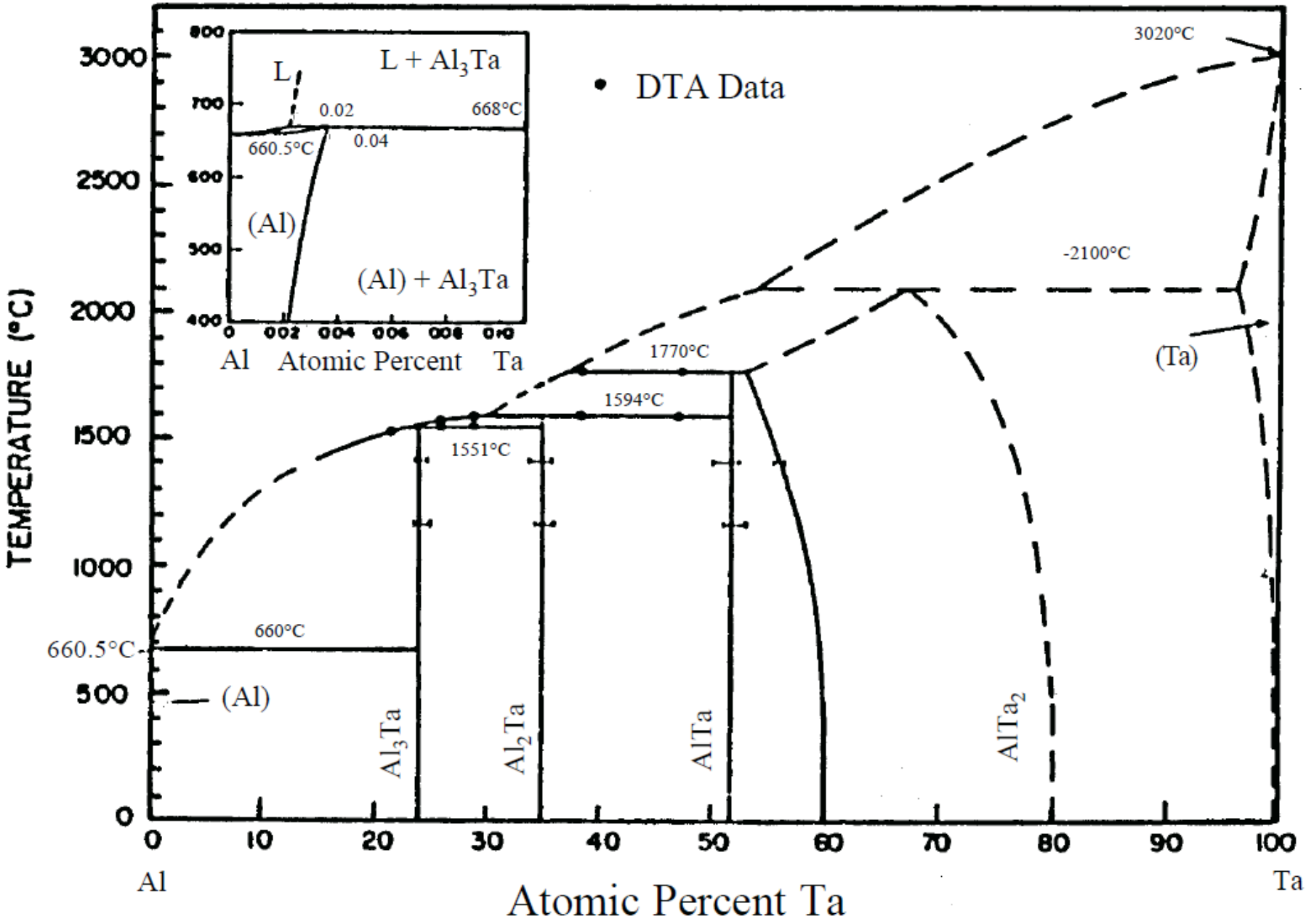


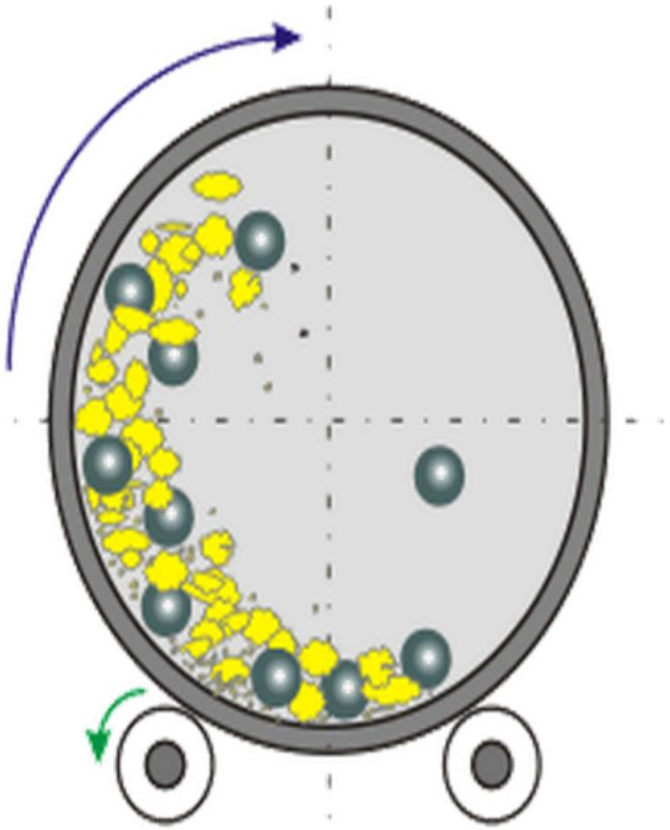
Figure 1.14. Phase relation of Al-Ta binary system. *(After Subramanian et al.)*[54]

-Background of MA……

History of Mechanical Alloying

- 1960's (INCO), coated oxide particles by nickel because of bad wetting.
- Coat metal powder alloy it self (1966), coat hard phase WC with soft phase Co or Ni.
- 1970, Benjamin use ball mill to produce (ODS) complex oxide dispersion-strengthened (Al_2O_3,…) .
- White, produce amorphous phase by milling Nb and Sn powders at room temperature.

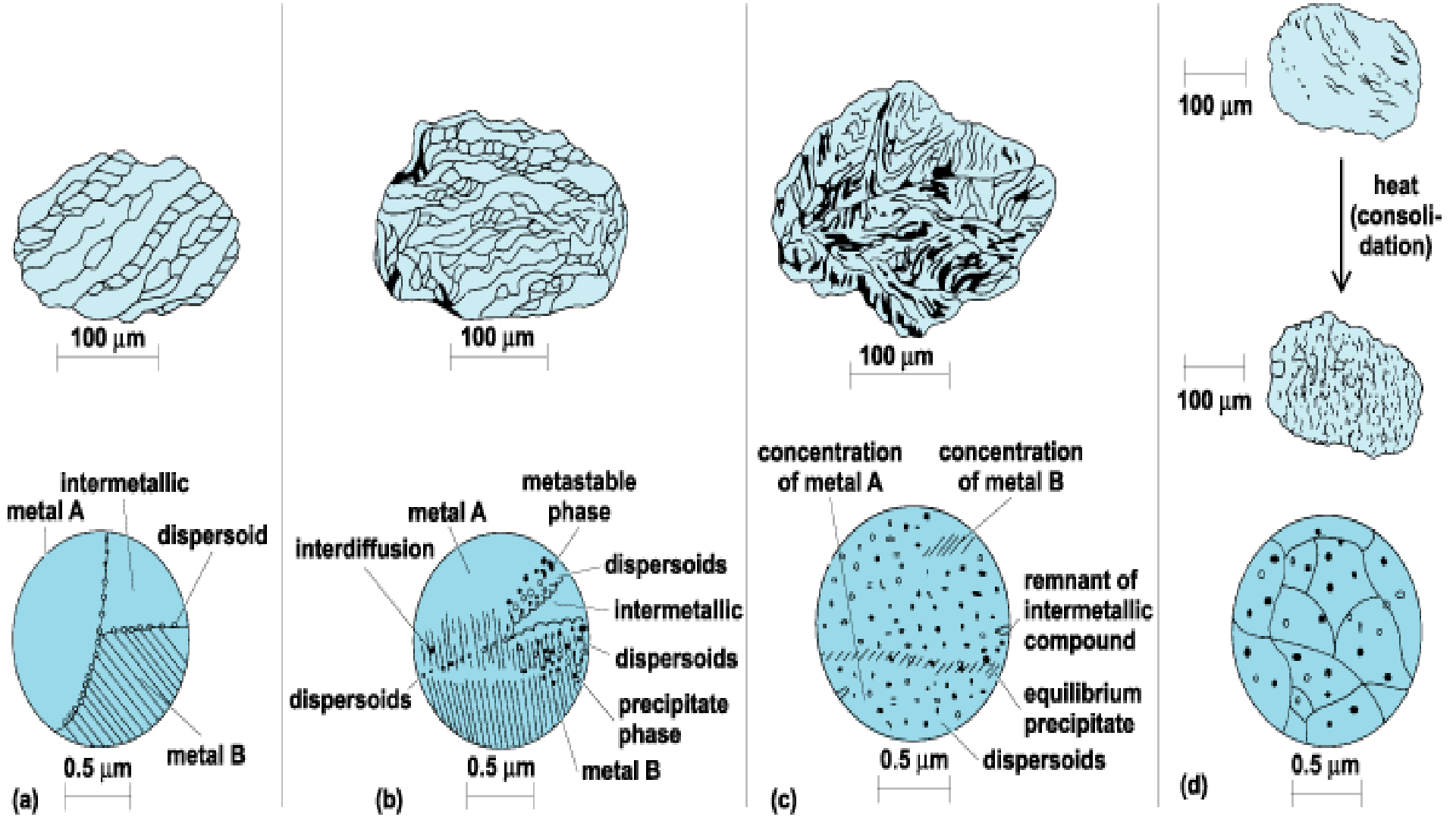
Milling

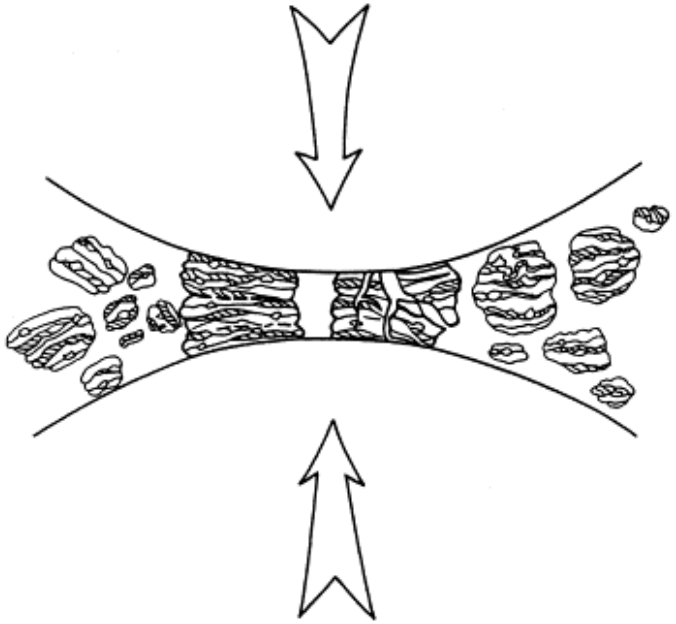


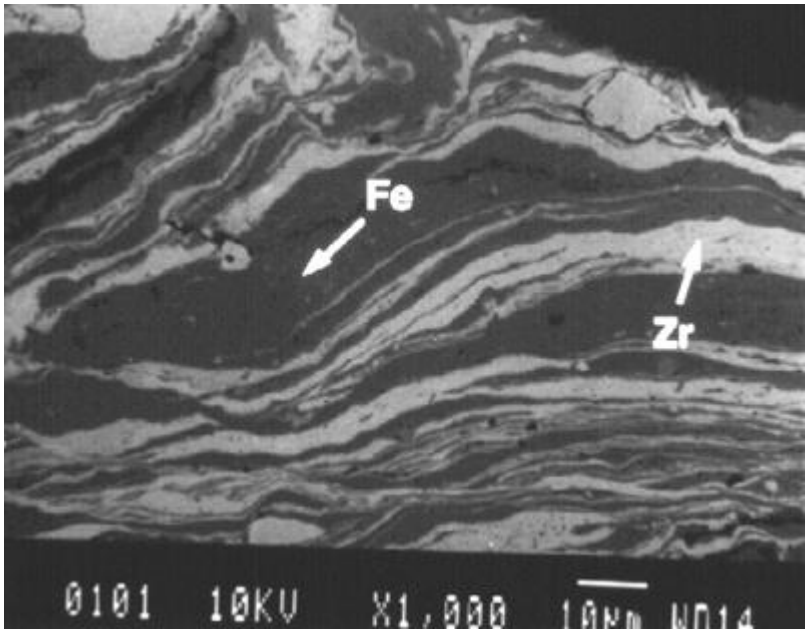
Ball mill is a grinder for reducing hard materials to powder. The grinding is carried out by the pounding and rolling of a charge of steel or ceramic balls carried within the cylinder. The cylinder rotates at a relatively slow speed, allowing the balls to cascade through the mill base, thus grinding or dispersing the materials.

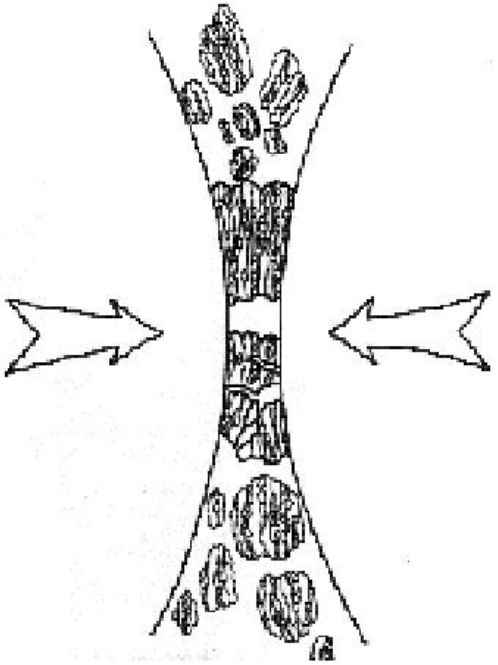
Type of ball mills, centrifugal and planetary mills, are devices used to rapidly grind materials to colloidal fineness (approximately 1 μm and below) by developing high grinding energy via centrifugal and/or planetary action.

Milling


100 μm
intermetallic
metal A
dispersoid
metal B
0.5 μm
(a)
100 μm
metastable
phase
metal A
interdiffusion
dispersoids
intermetallic
dispersoids
dispersoids
precipitate
phase
0.5 μm
metal B
(b)
100 μm
concentration
of metal A
concentration
of metal B
remnant of
intermetallic
compound
equilibrium
precipitate
0.5 μm
dispersoids
(c)
100 μm
heat
(consoli-
dation)
100 μm
0.5 μm
(d)




Fe
Zr
0101 10KV X1,000 10Nm WD14



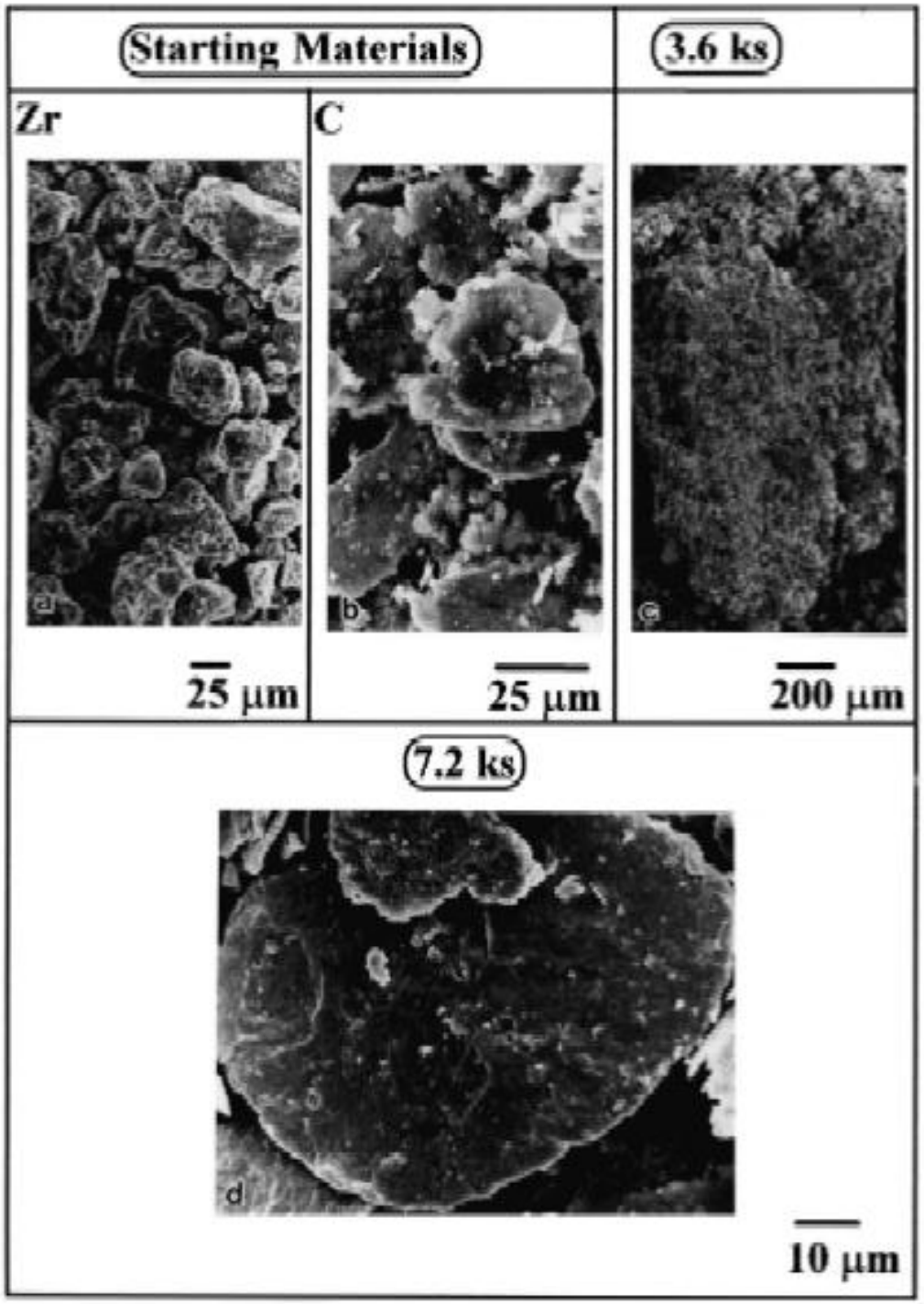


Fig. SEM micrographs of elemental
(a) Zr, and (b)C powders at the starting stage of milling.
The SEM micrographs of the powders at the early stage of milling are presented after (c) 3.6 ks and (d) 7.2 ks of the milling time.
After Amir Mahdy et al.

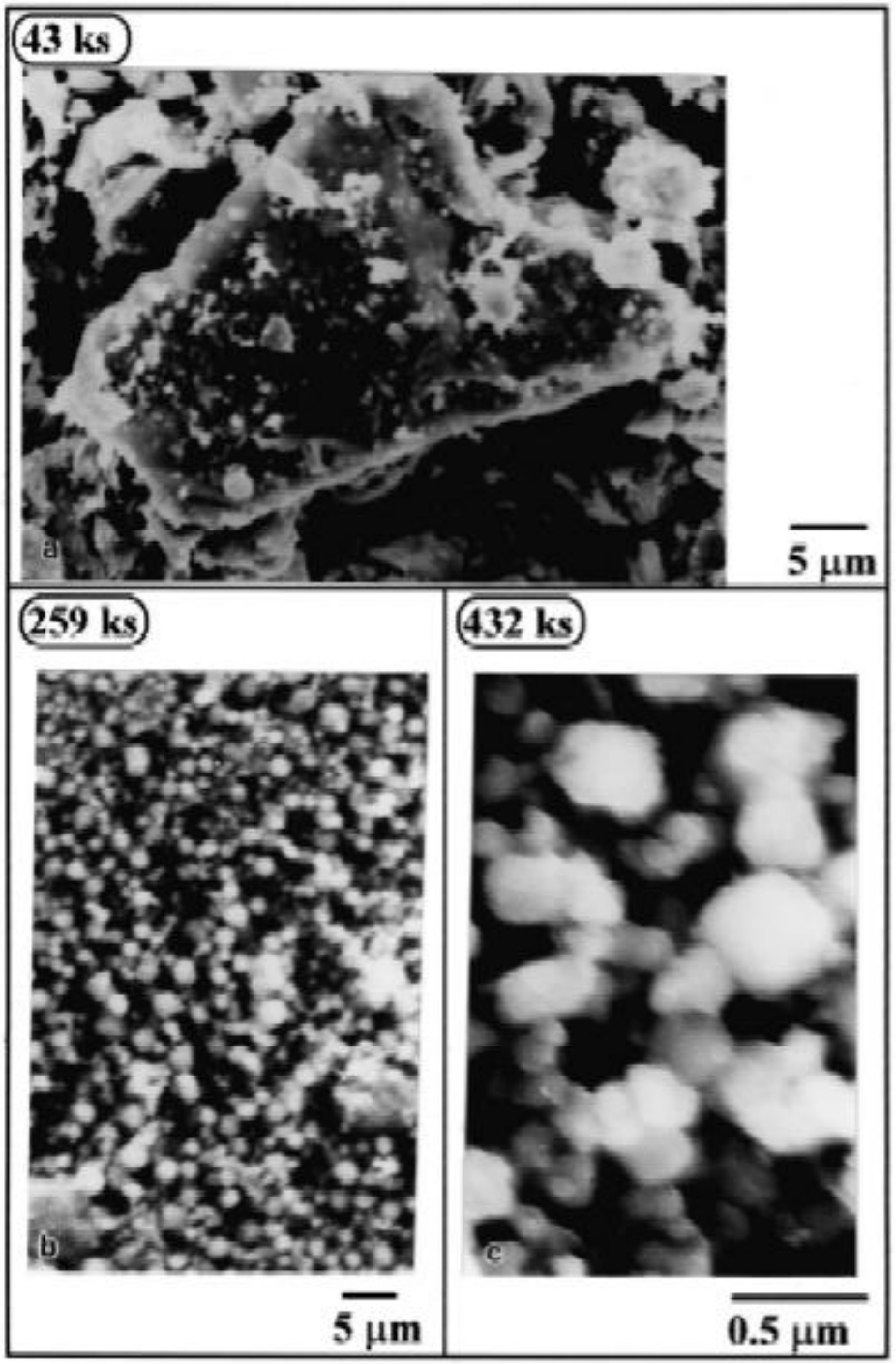


Fig. SEM micrographs of the powders at the (a) intermediate stage of milling (43 ks)= (12hrs) and (b), and (c) final stage of milling, 259 (3 days) to 432 ks (5 days) of the milling time.

After Amir Mahdy et al.

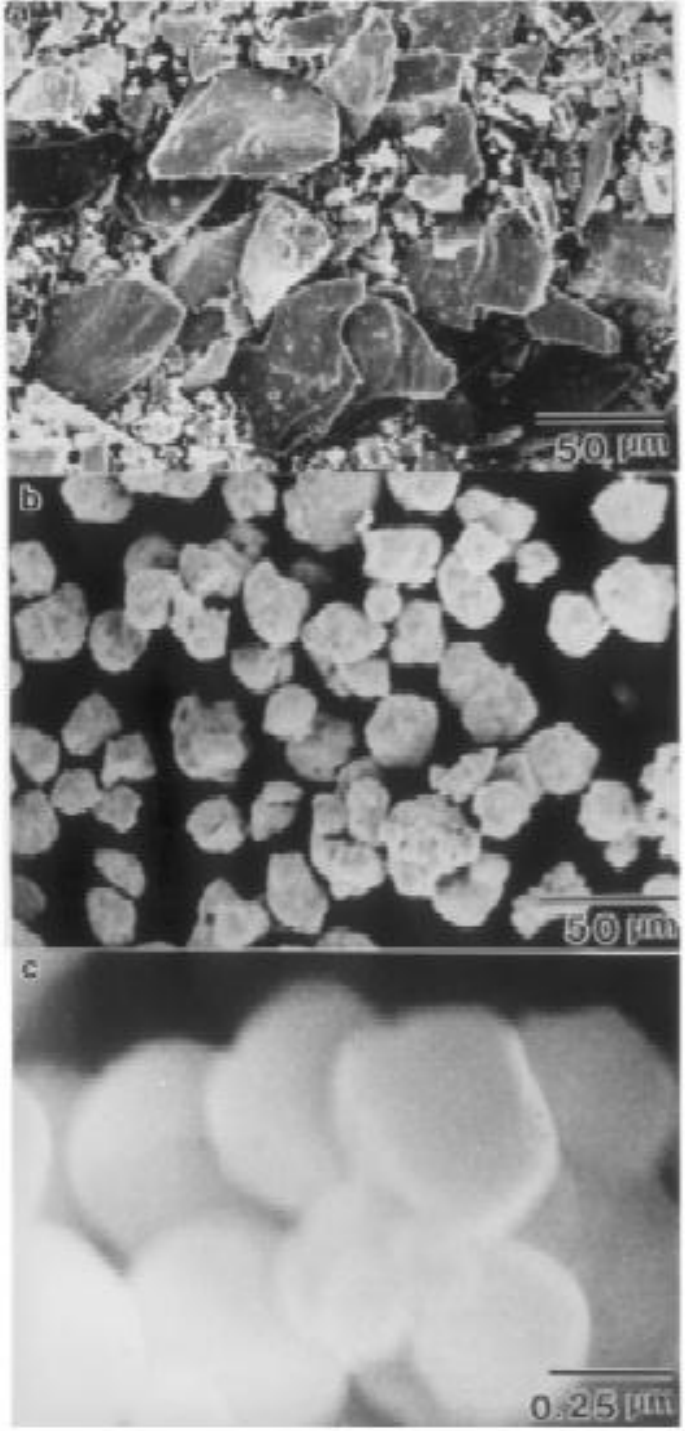
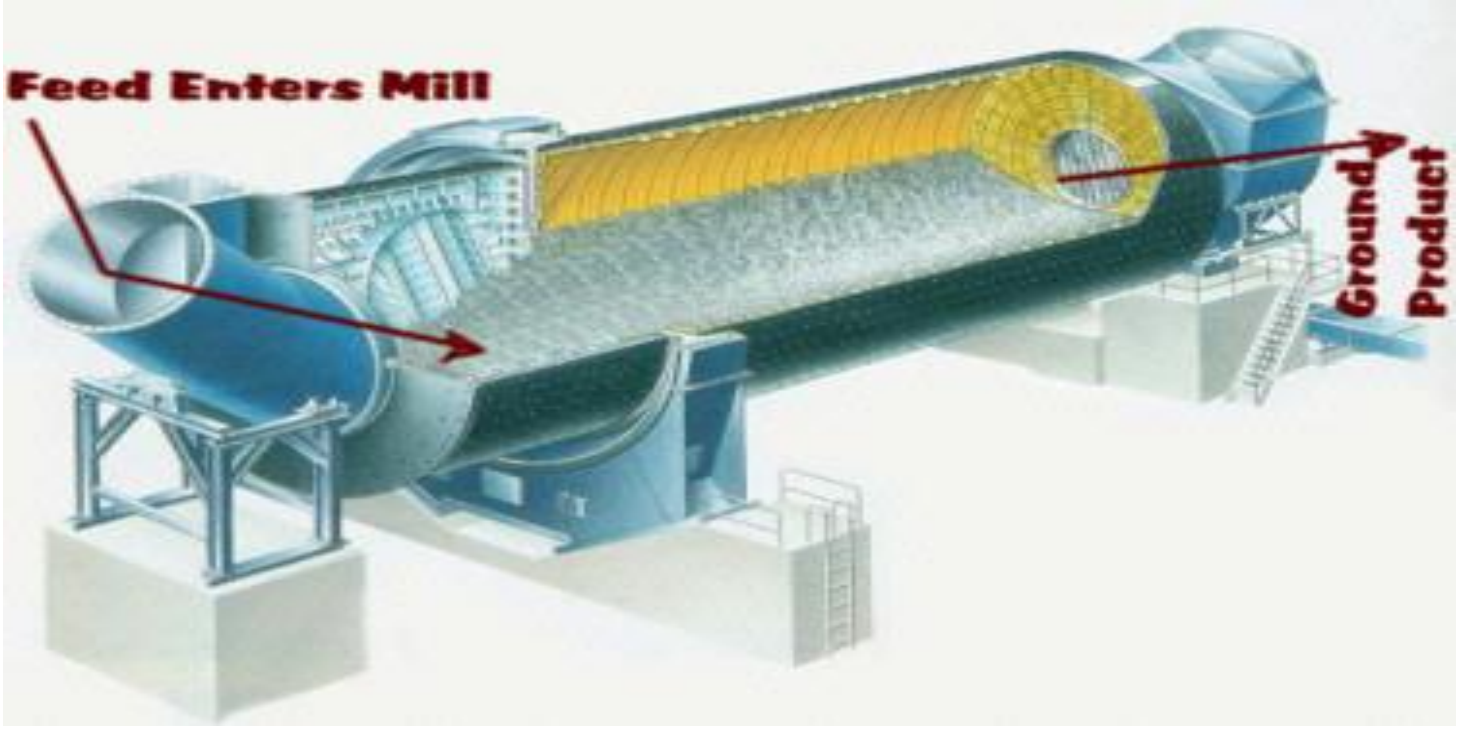


Fig. SEM micrographs of ball-milled W_{50} C_{50} powders after
(a) 22 ks (6 hrs),
(b) 173 ks (48 hrs)and
(c) 432 ks (5 Days) of mechanical alloying.
After El-Eskandarany et al.

Types of mills

- Low energy ball mill.
- Attritor mill.
- Planetary ball mill.
- Vibratory ball mill.
- High energy ball mill.


Feed Enters Mill
Ground Product

Factors Affecting the MA

1- Mill type.

2- Milling atmosphere.

3- Ball-Powder weight ratio.

4- Milling time.