AT9900071

Coating of ceramic powders by chemical vapor deposition techniques (CVD)

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New ceramic materials with selected advanced properties can be designed by coating of ceramic powders prior to sintering. By variation of the core and coating material a large number of various powders and ceramic materials can be produced. Powders which react with the binder phase during sintering can be coated with stable materials.

Thermal expansion of the ceramic materials can be adjusted by varying the coating thickness (ratio core/layer). Electrical and wear resistant properties can be optimized for electrical contacts. A fluidized bed reactor will be designed which allow the deposition of various coatings on ceramic powders.

Workshop on Metal/Ceramic Compo
for Functional Application
June 5-6, 1997, Vienna / Austria

COATING OF CERAMIC POWDERS BY CHEMICAL VAPOR DEPOSITION TECHNIQUES (CVD)

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coating	/	powder	application
TiN	/	TiC	+ Si_3N_4 structural ceramic
Al_2O_3	/	SiC	structural ceramics
TiN	/	Al_2O_3	- " -
AlN	/	SiC	high thermal conductivity, low thermal expansion
C	/	U, Th	feed- and breed-materials
TiN	/	Fe	oxidation resistance
TiB_2 - TiN	/	Fe	- " -
Al	/	mica	pigment with various colours
TiN	/	mica	- " -
TiO_2	/	mica	- " -

CVD coatings on powders

Coating / powder variations described in literature

reactors:

fluidized bed
floating-type fluidized bed

rotary powder bed

vibration bed

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CVD coatings on powders

Various reactors for coating of powders described in literature

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$$V_S = [4 \times g \times d_P \times (D_P - D_G) / (3 \times D_G \times C_W)]^{-0.5}$$

V_S = terminal velocity (velocity of single particle)
g = gravitation
d_P = particle diameter
D_P = density of particle
D_G = density of carrier gas
C_W = resistance coefficient

$$C_W = 24 / Re + 4 / Re^{0.5} + 0.4$$

Re = Reynolds number

$$V_G = V_S \times \varepsilon^{4.65} \qquad \varepsilon = 1 - e$$

V_G = super ficial velocity
ε = porosity
e = solid loading

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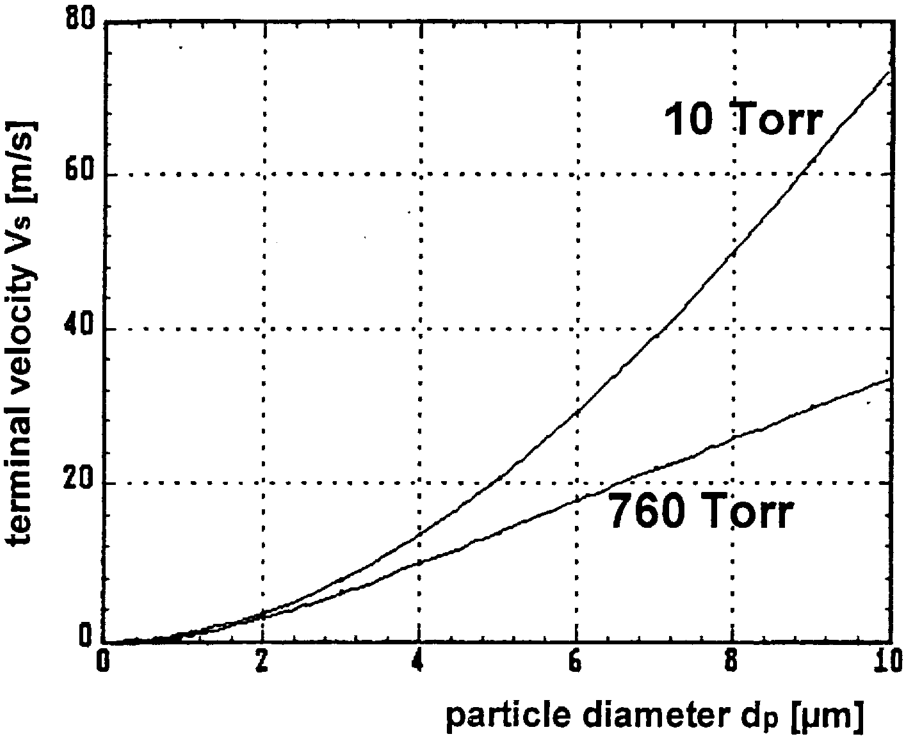
Fluidized bed reactors

Equations to calculate fluidization systems



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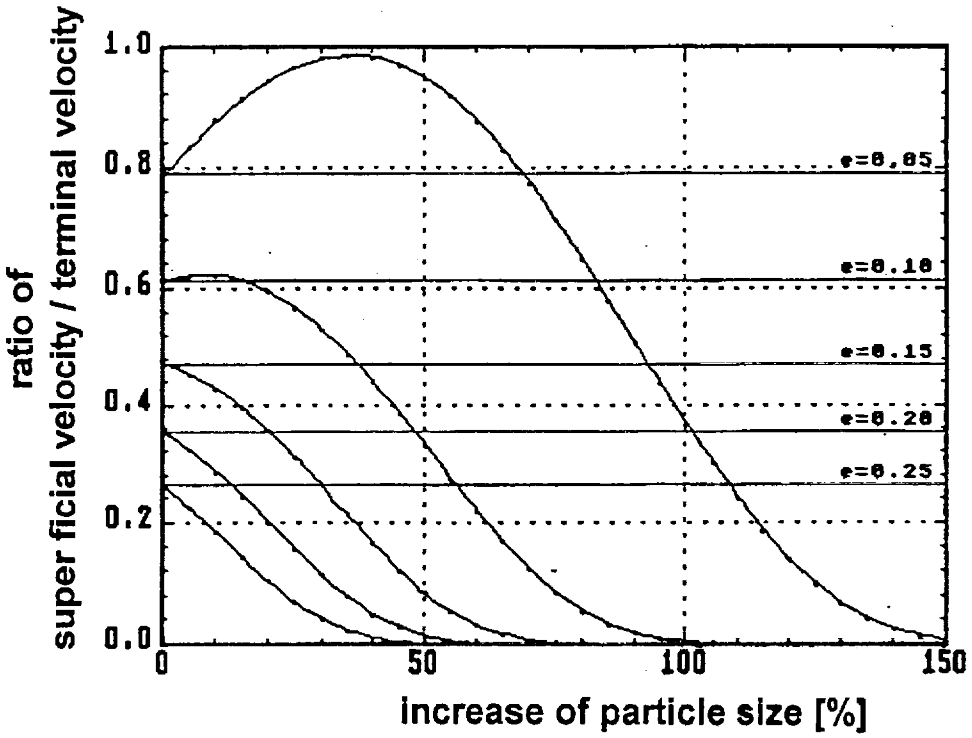
Fluidized bed reactors

Terminal velocity for various particle diameters and two gas pressures (diamond powder, hydrogen, 1000K)



e = loading with powder at the beginning of the CVD reaction

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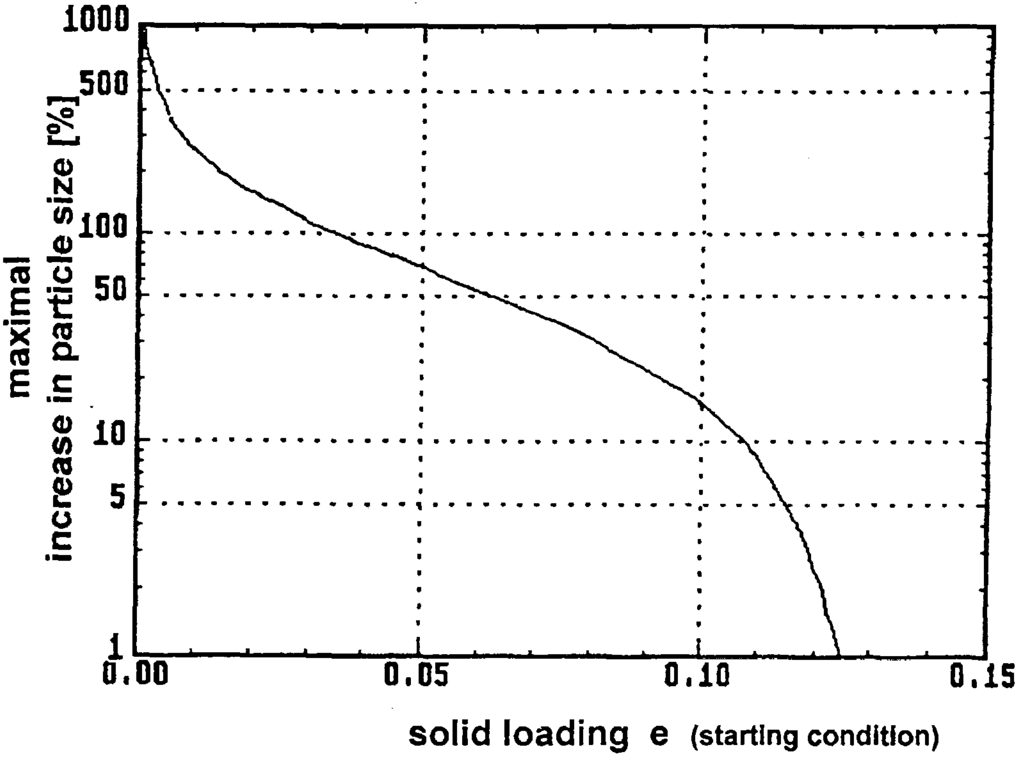
Fluidized bed reactors

Changes in gas velocity during particle growth (constant density)



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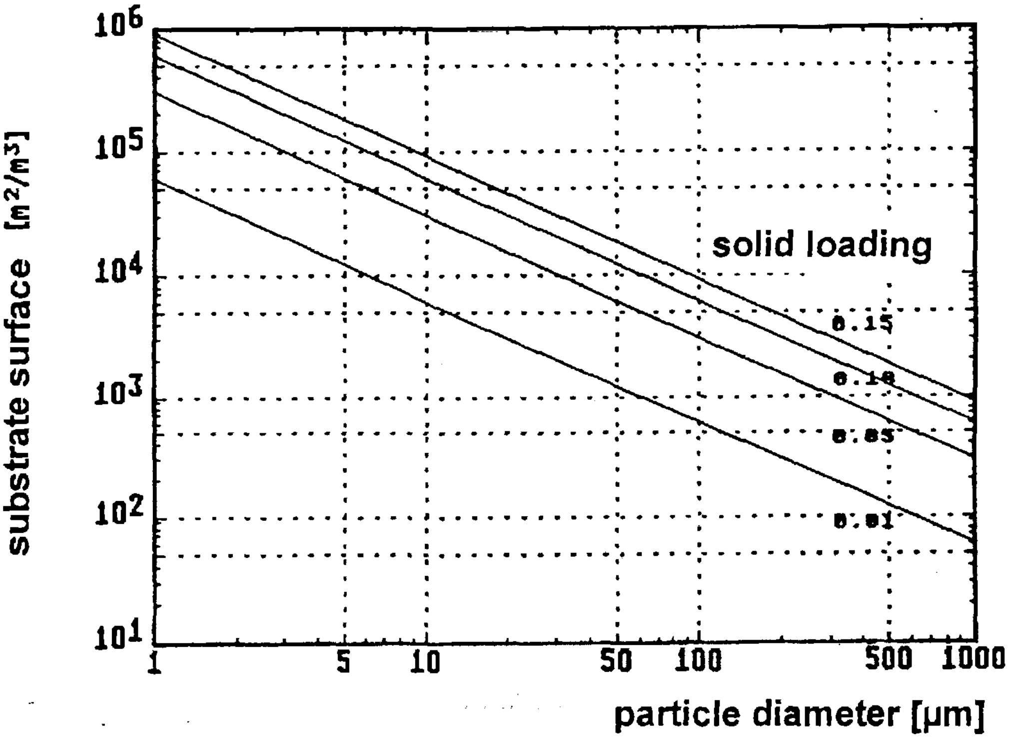
Fluidized bed reactors

Comparison of partical growth and solid loading

(velocity in reactor is constant)



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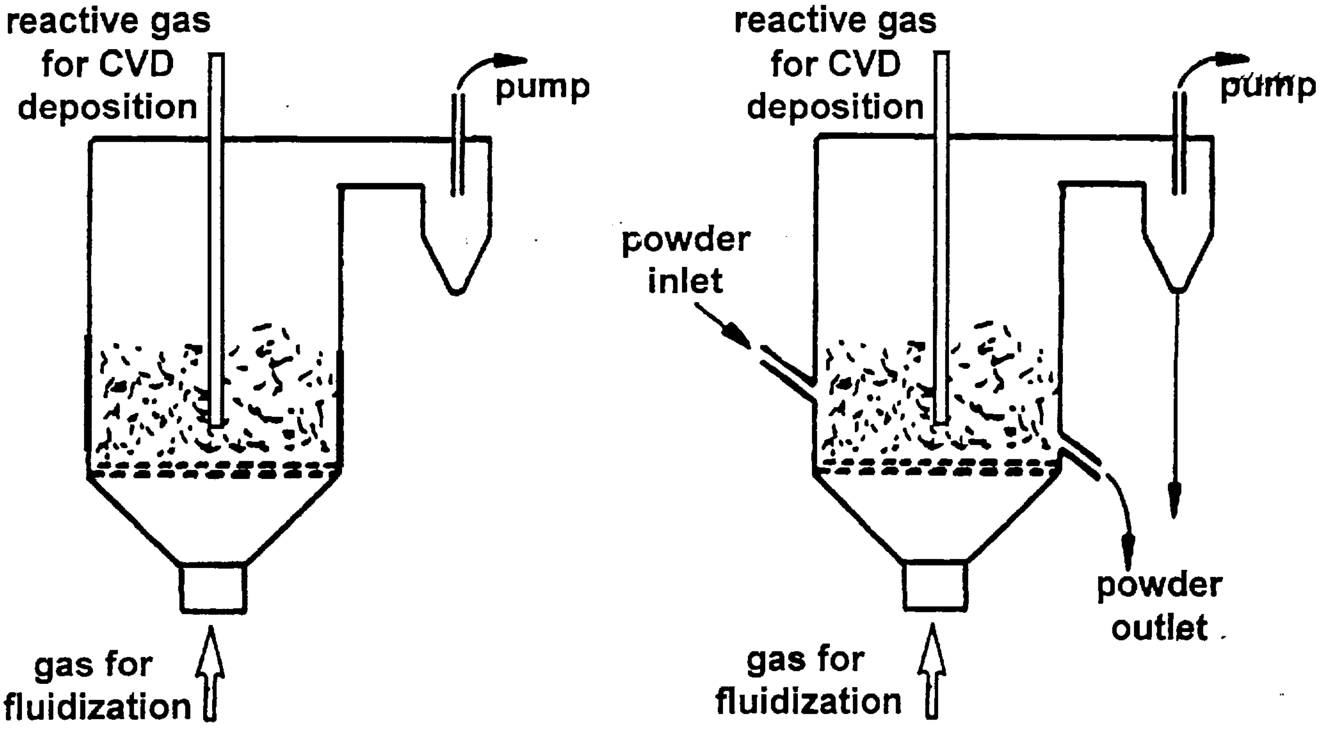
Fluidized bed reactors

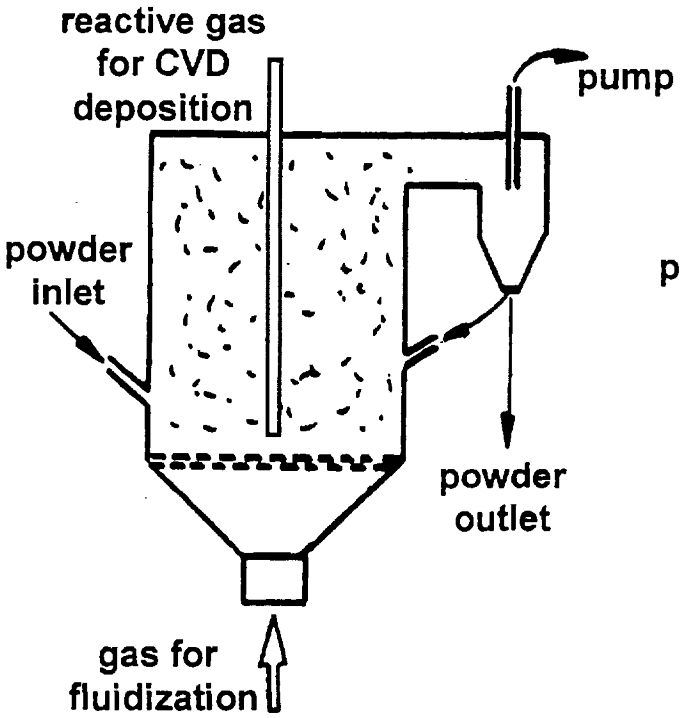
Comparison of partivle diameter to particle volume and solid loading



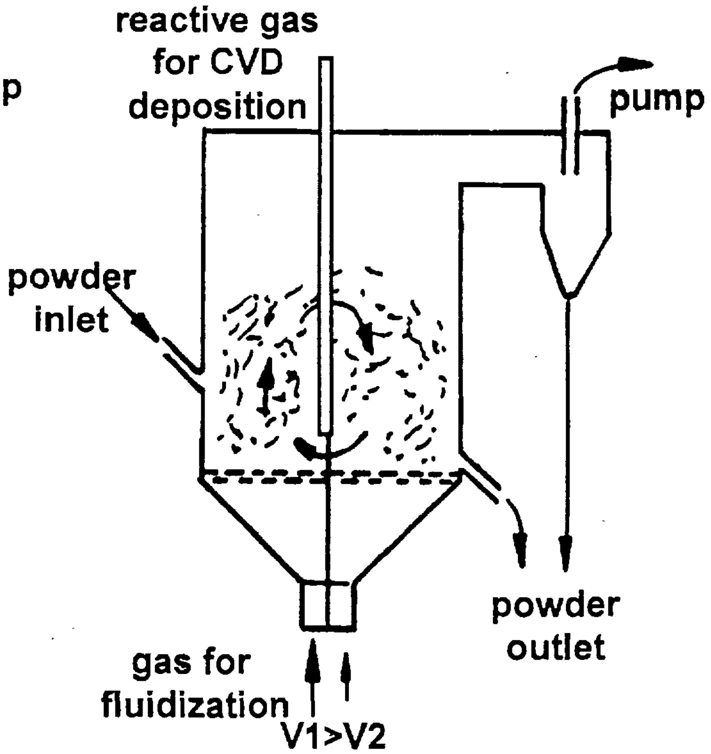
CVD coating of powders

Fluidized bed reactors

external circulation

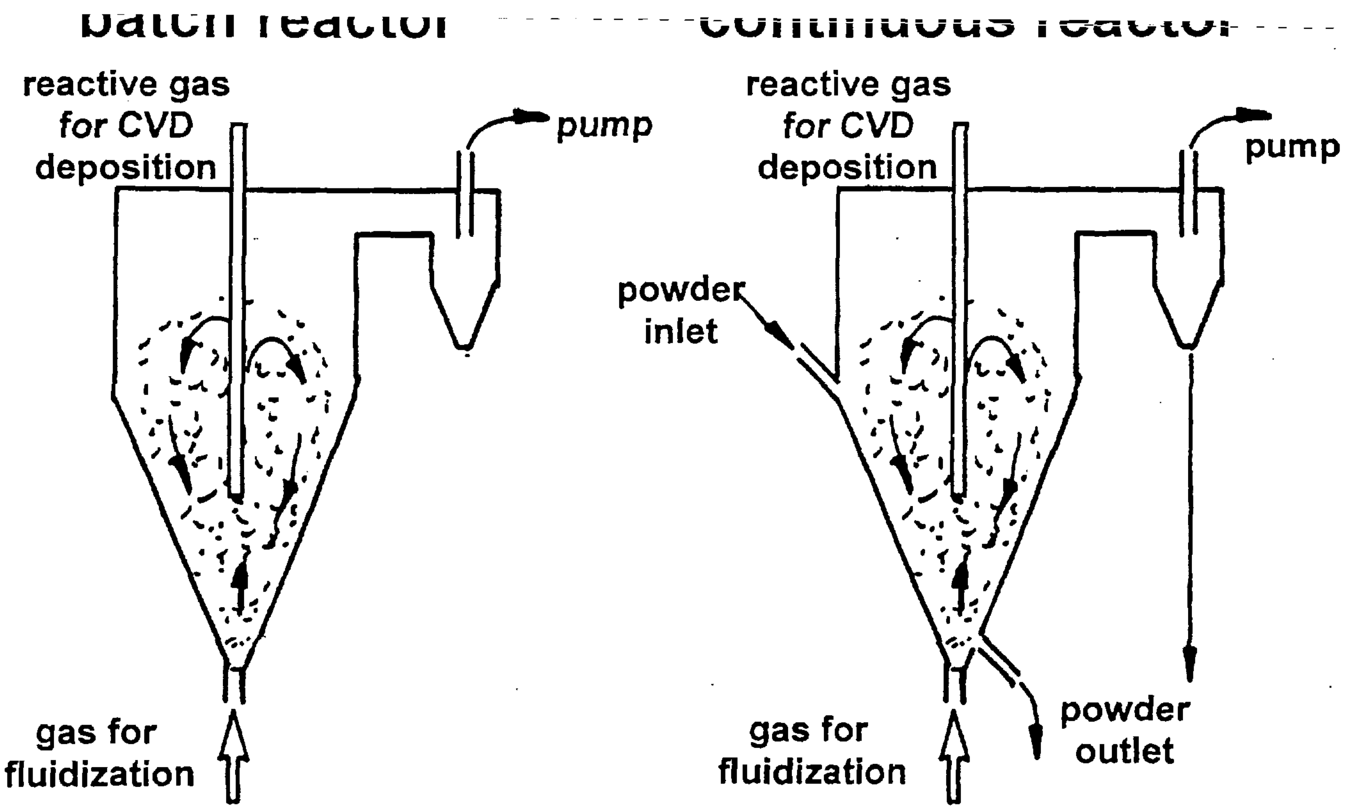


internal circulation



CVD coating of powders

Fluidized bed reactors with circulation



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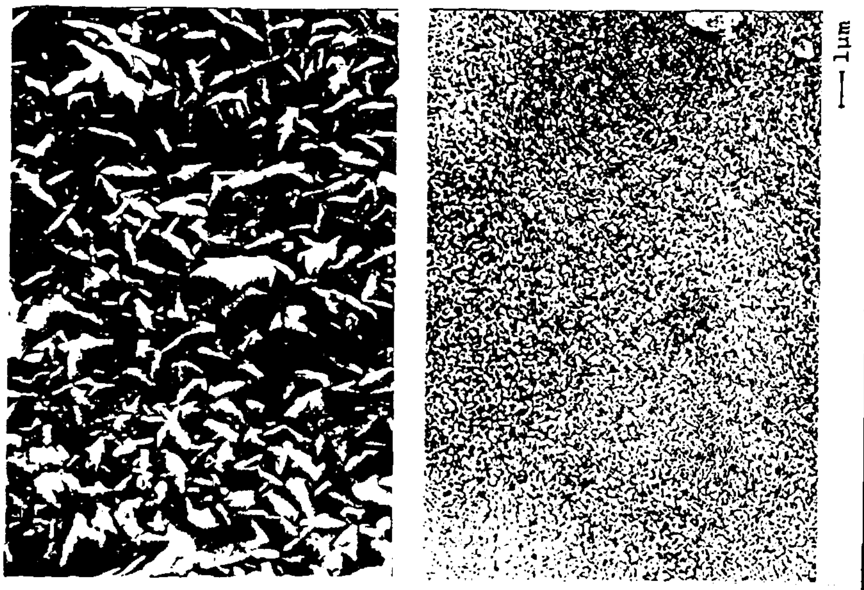
CVD coating of powders

Stream bed reactors



CVD: TiC LAYER

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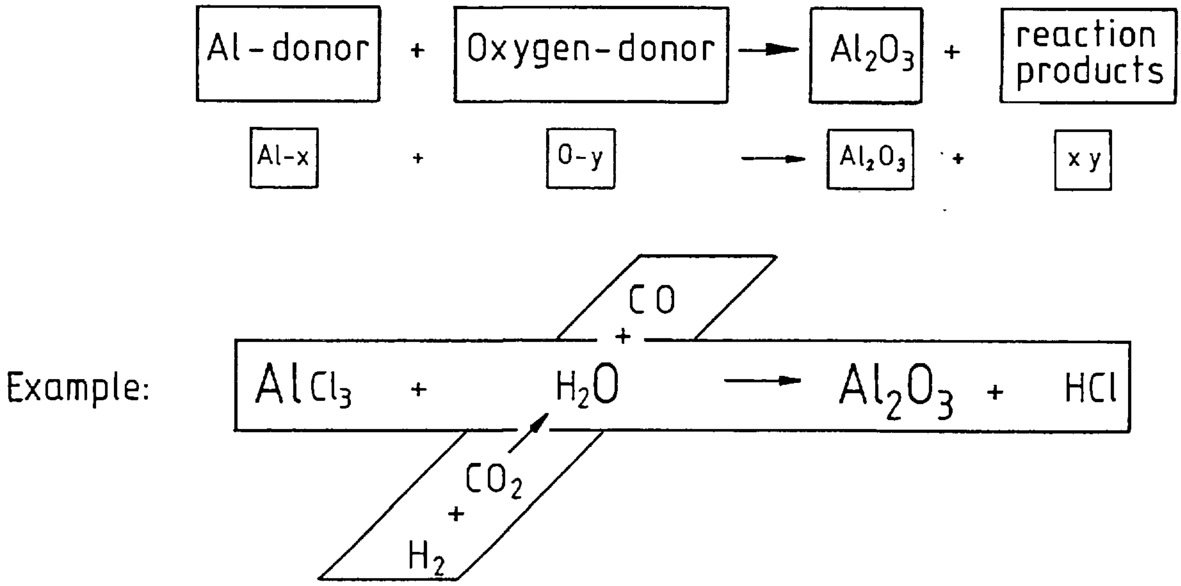

Al-donor + Oxygen-donor → Al_2O_3 + reaction products

Al-x + O-y → Al_2O_3 + xy

Example: $AlCl_3$ + H_2O → Al_2O_3 + HCl

CO +

CO_2 + H_2

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CVD GROWTH OF α-Al_2O_3

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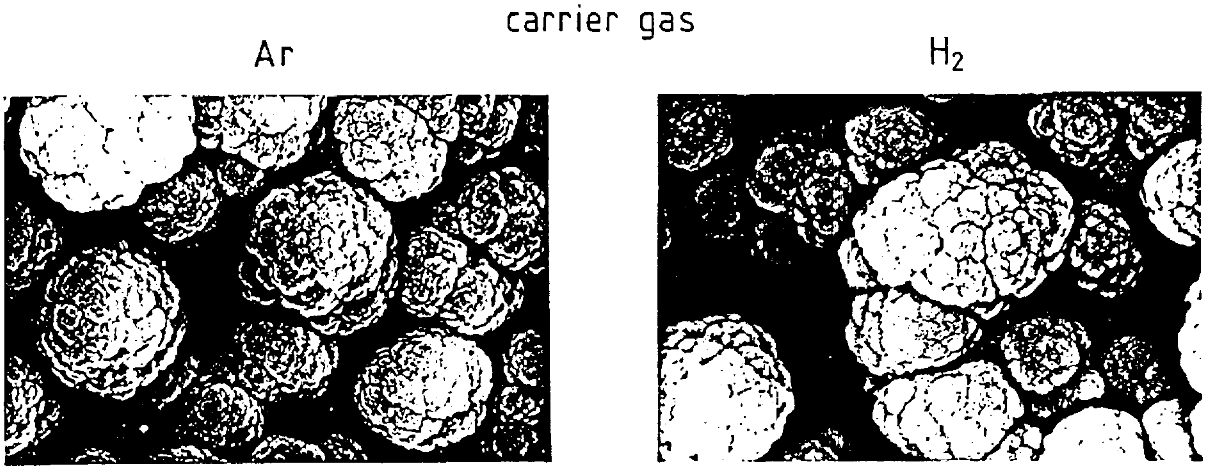
carrier gas



CVD growth of α-Al_2O_3
Al(O-iPr)$_3$ decomposition on
WC/Co/TiC substrates

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Al_2O_3/TiC MULTILAYER

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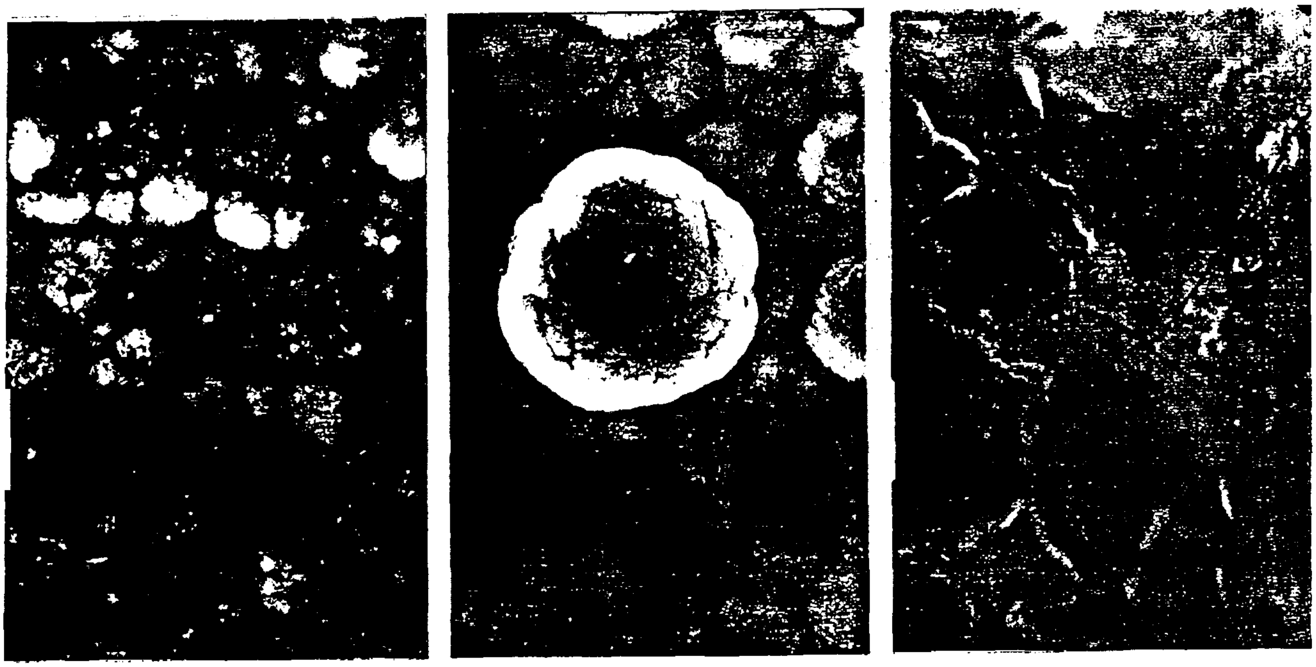
1100°C 1200°C 1300°C

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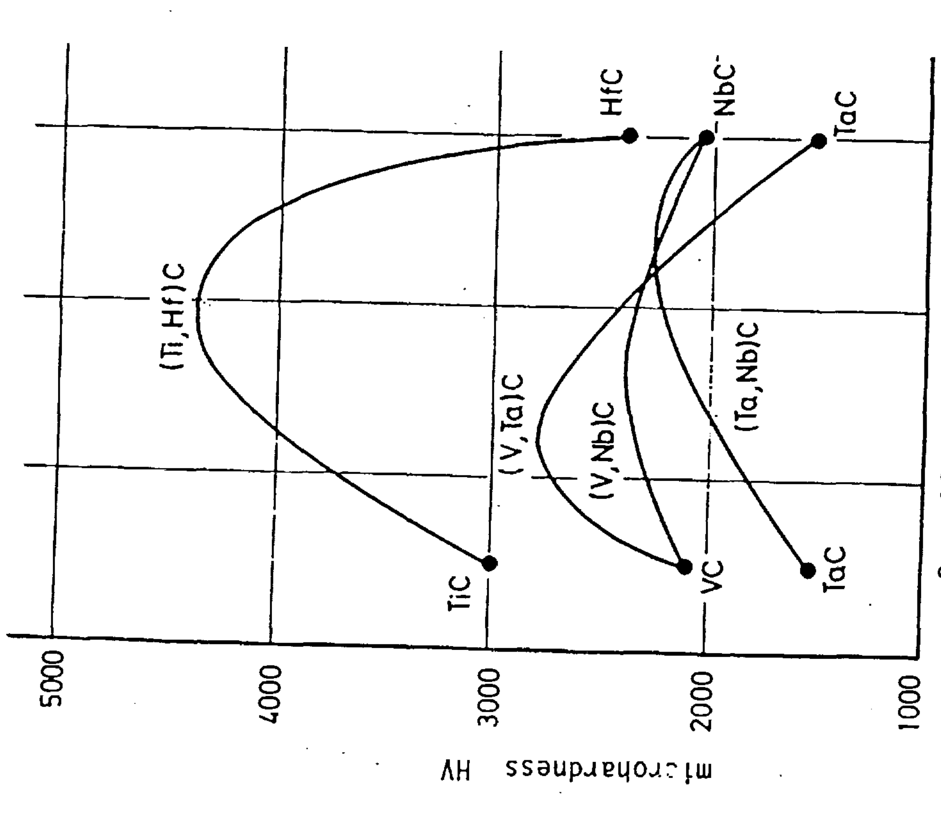
β-SiC deposition from $CH_3SiH_2SiH_2CH_3$ on WC-Co
Changing deposition temperature

X. TANG



HARDNESS OF MIXED CARBIDES

acc. to Holleck

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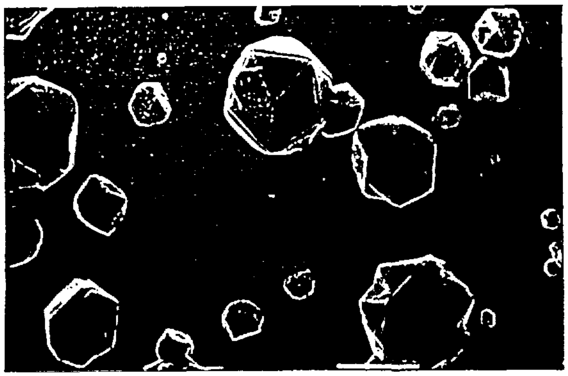
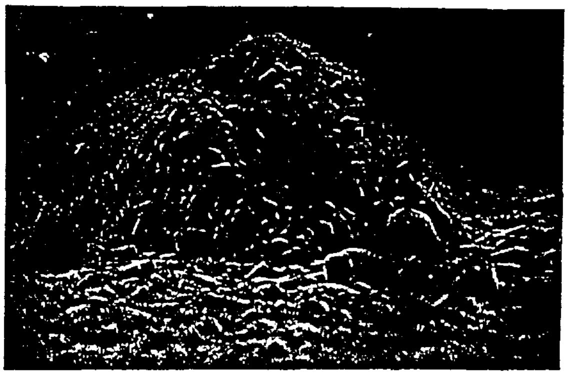


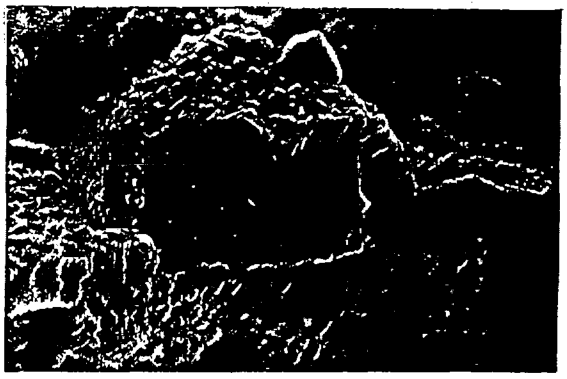
deposition of diamond

10 µm

cracks in Al_2O_3



coated with Al_2O_3



10 µm

fracture

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COMPOSITE LAYER: LOW PRESSURE DIAMOND, CORUNDUM

Thermal CVD; Substrate: WC/Co/TiC

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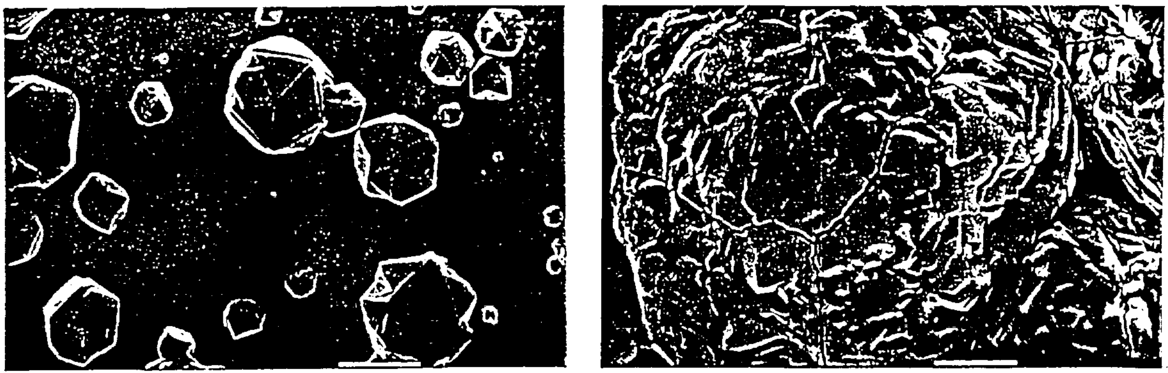
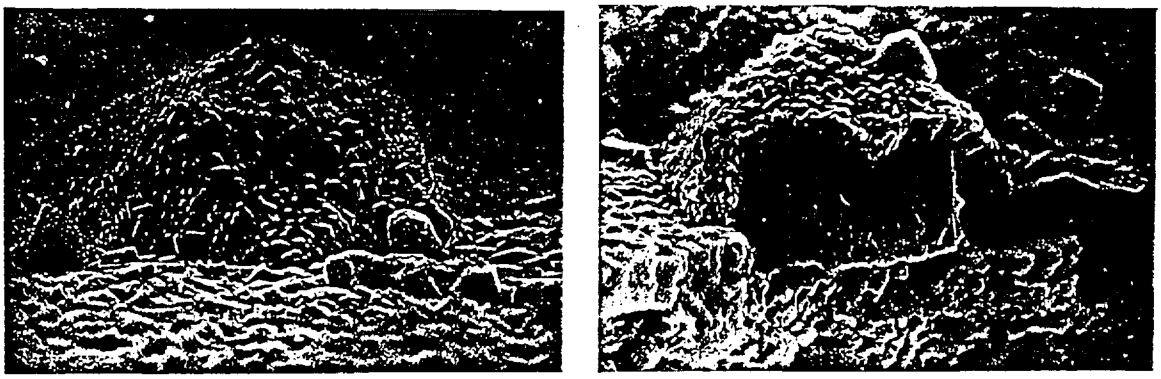


deposition of diamond ——— 10 µm cracks in Al_2O_3



coated with Al_2O_3 ——— 10 µm fracture

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COMPOSITE LAYER: LOW PRESSURE DIAMOND, CORUNDUM

Thermal CVD; Substrate: WC/Co/TiC

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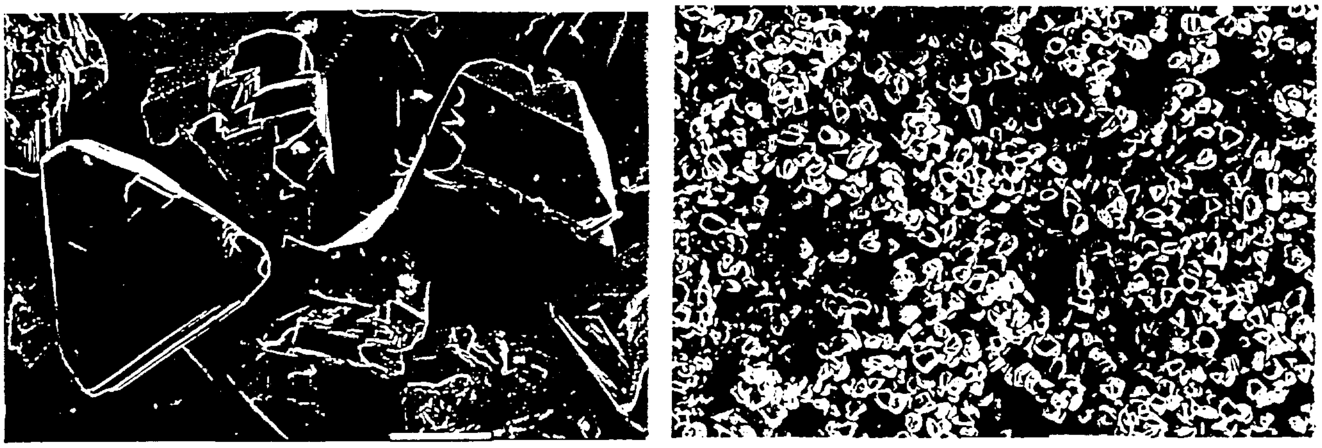

——— 100 µm

well-facetted non-facetted

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cub-BN (WURZITE TYPE)

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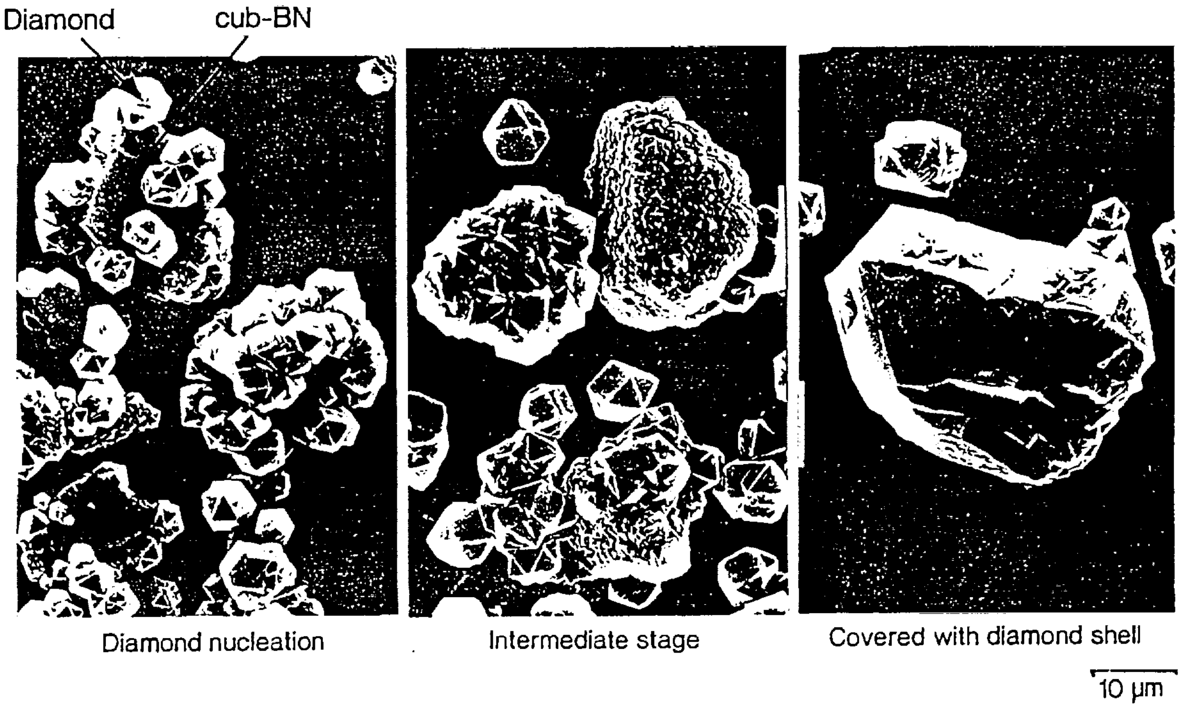

Diamond nucleation

Intermediate stage

Covered with diamond shell

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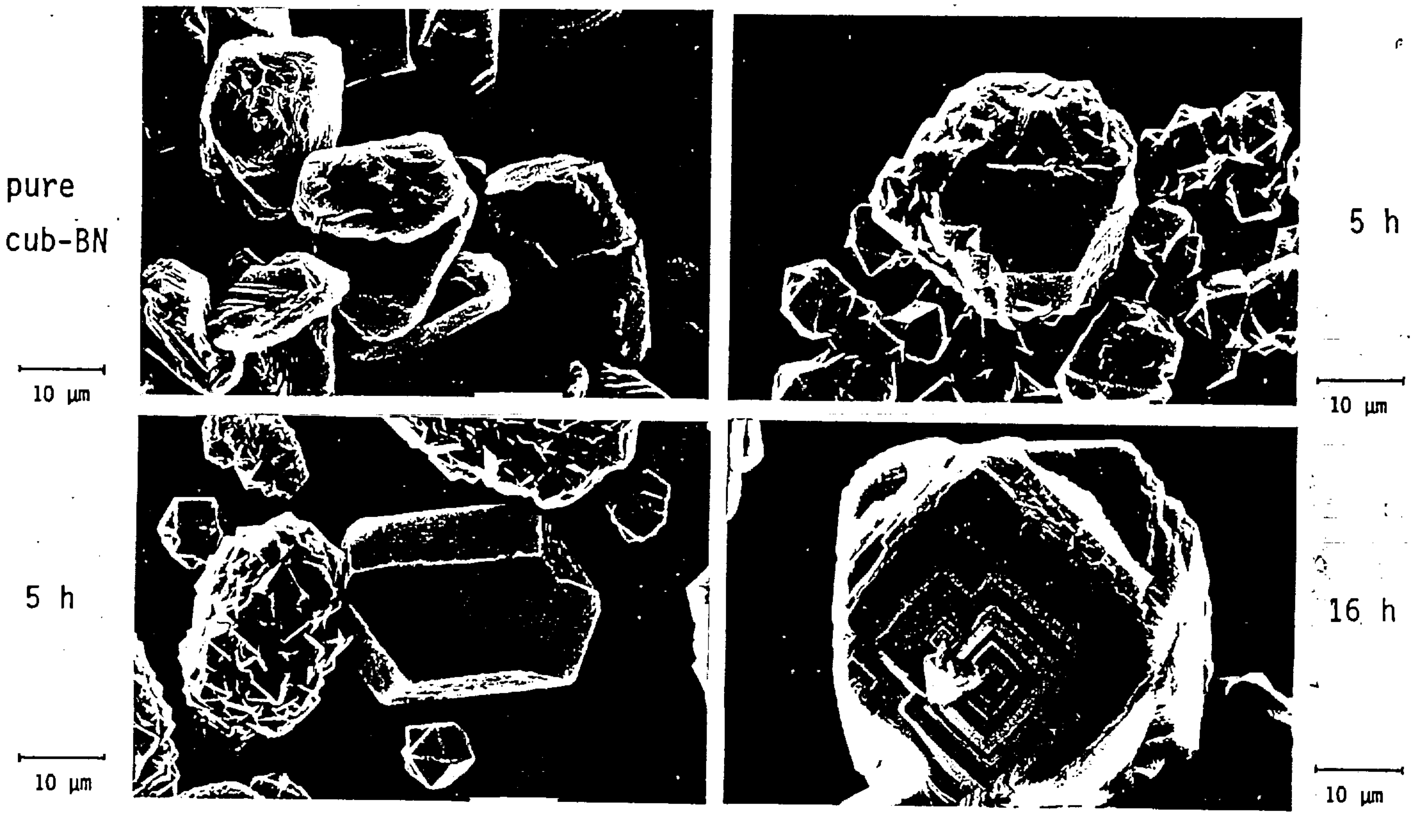
COMPOSITE POWDERS

cub-BN core/ diamond shell



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LOW-PRESSURE DIAMOND:

Epitaxial growth on non-facetted cub-BN powder

Thermal CVD

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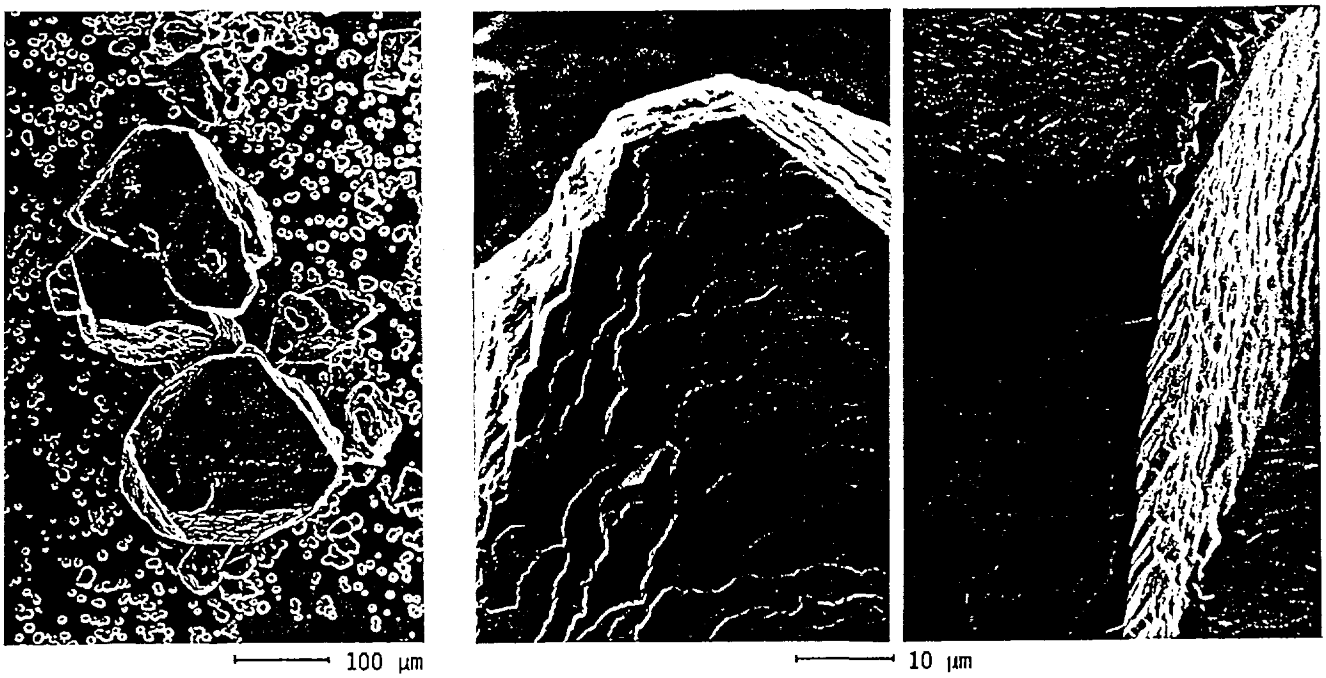

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LOW PRESSURE DIAMOND

Thermal CVD: growth on cub-BN
Deposition time: 5 h

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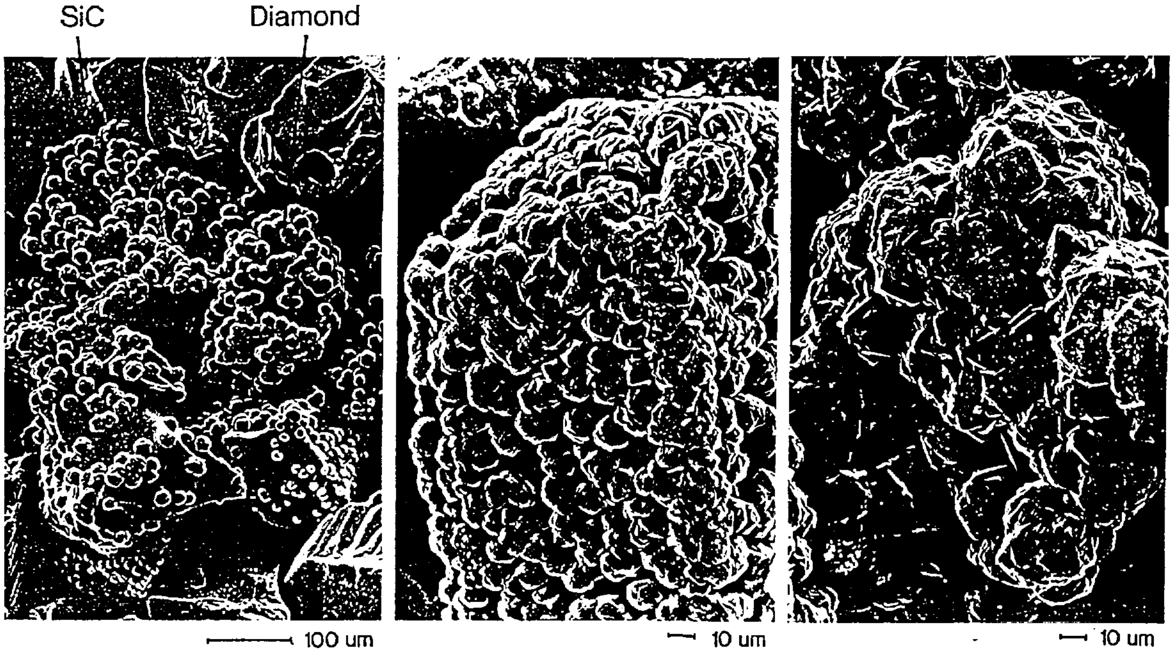

Diamond nucleation Intermediate stage Covered with diamond shell

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COMPOSITE POWDERS

SiC core/ diamond shell

LITOS 1988

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