Initial Wetting System - Introduction

The initial wetting of aluminium has a significant influence on the efficiency of the evaporation process.

The "Initial Wetting System" is characterized by an improvement of the initial wetting of aluminium.

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Initial Wetting System – Status Quo

Break in difficulties of **un**used evaporators regarding **wetability** of aluminium

Reason for that difficulties:

- The **un**used evaporator consist of approx. 65 **Vol**.% of Boron-Nitride (BN) which is hard to wet by aluminium.
- Boron-Nitride (BN) is "aluminophob" because of the **anisotropic crystal structure**.

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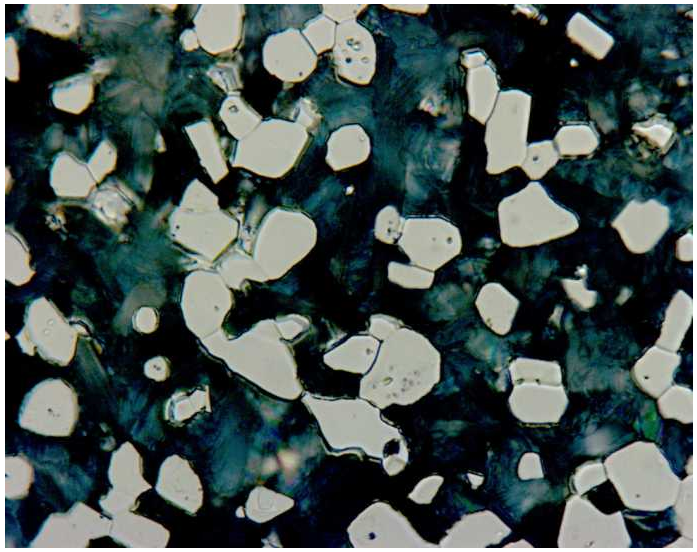
Structure of IMC-Evaporators

65 **Vol.**% of Boron-Nitride (BN) which is hard to wet by aluminium.



Etched Surface of an IMC-Evaporator boat

Dark areas = BN

Light-coloured areas = TiB_2

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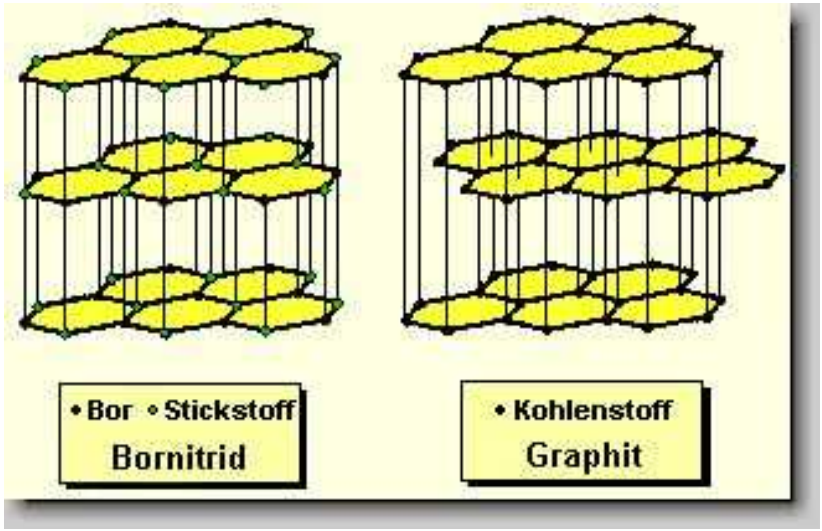
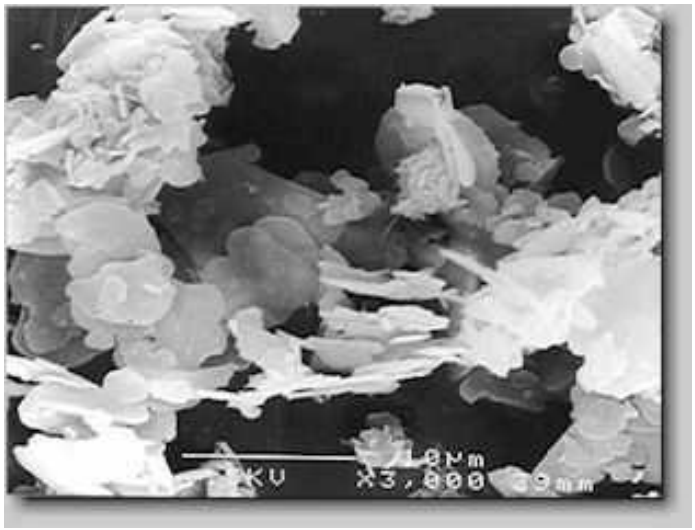
Crystal Structure of Boron-Nitride



Crystal Structure of BN (Bornitrid) – schematically



Plates of BN; SEM-analysis (3000x; SE)

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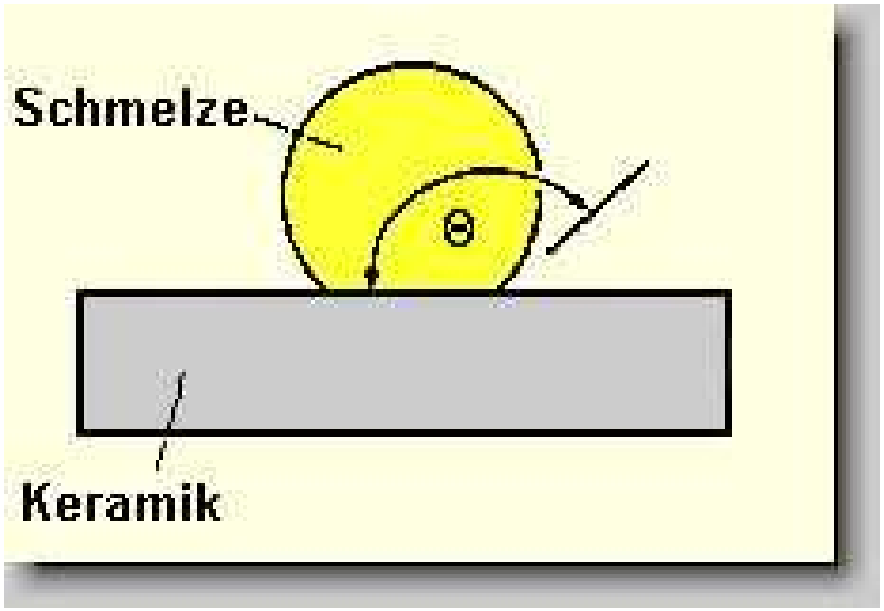
Wetablity in General



Definition of the „wetting angle of contact Θ" on ceramic substrates

Comment:
Wetting angle of contact Θ > 90°:
bad wetability

Wetting angle of contact Θ < 90°:
good wetability

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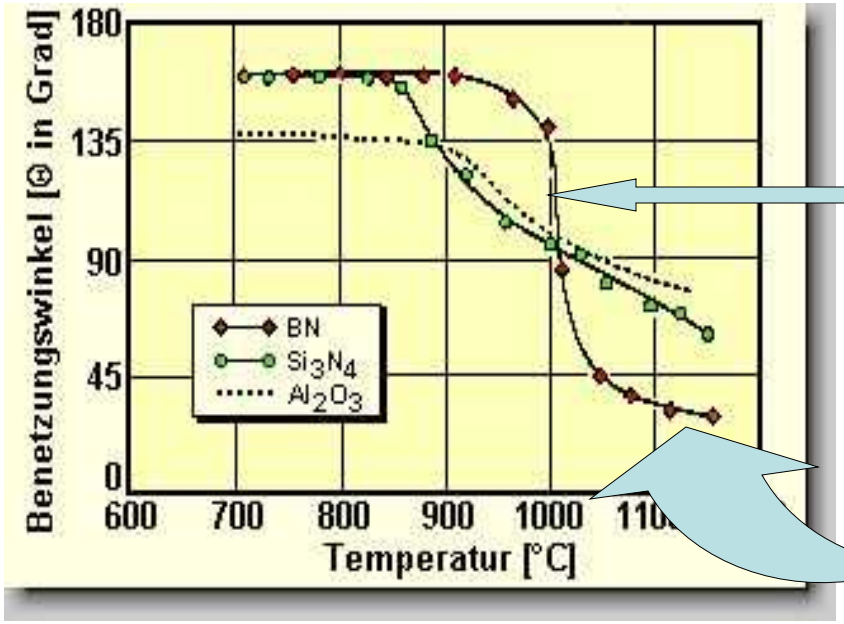
Wetablity in General



Comments:

At 1000°C BN reacts with Al building **AlN**.

Therefore at >1000°C you can see the good wetability of Alon **AlN**.

Wetability of aluminium on BN (AlN), Si_3N_4, Al_2O_3 surfaces in dependence of the temperature

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Vapour Pressure and Evaporation Temperature

Vapor pressure	Evaporation temperature of Al in °C
$1,33 * 10^{-4}$ mbar	920 °C
$1,33 * 10^{-2}$ mbar	1140 °C

Evaporation temperature of Al in dependence of the vapour pressure

Comments:
You see that the liquid **Al evaporates before** building up the good wetable AlN at 1000°C.
Therefore the aluminium can be only partial distributed onto the evaporator surface.

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Some Questions

Why does evaporator boats consist of BN?

BN provide:

- A very good thermal shock resistance
- The right specific resistivity (electrical insulator)
- A good machinable material

What´s the reason for good wetting of Al after a certain time of continuously Al-feed?

BN get decomposed on the hotter, not wetted evaporator surface area during metallization

The remaining TiB_2 of the evaporator boat material is a wetting catalyzer.

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Initial Wetting System - Theoretical Background

A) Components of the Initial Wetting System

"Initial Wetting System" = a **combination** of **aluminium** and a **wetting agent**

Compounds of the wetting agent: Ti and Si.

Initial Wetting System - Theoretical Background

B) First Heating Up of the Initial Wetting System

T = 700-1000°C
The wetting agent **reduces** the **"wetting angle of contact"** of the Al
This effect helps to distribute the liquid Al.

T = approx. 1000°C
Al **reacts with the BN** of evaporator surface building AlN.
Al wets AlN well.

T > 1000°C
The residual Al evaporates.
There remains a thin **AlN-layer** which covers almost the whole cavity surface of the evaporator.

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Initial Wetting System - Theoretical Background

C) Continuous Al-Wire Feed

The thin AlN-layer on the evaporator surface is wetted by Al much better than BN

The wetting area is bigger than usual.

The wetting is more homogeneous than usual.

By proper running conditions the good wetting can be maintained from the beginning to the end of the evaporator boat life.

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Initial Wetting System – Possible Concern

A) Toxicity

The wetting agents consist of a compound of Titanium and Silicon.

=> Both elements are **not critical** with regard to food contact.

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Initial Wetting System – Possible Concern

B) Quantities – A Calculation Example

In a 99,8 % Al-wire (99,8%) can be found Titanium and Silicon as impurities as follows:
Ti = approx. 0,02%
Si = approx. 0,15%

Sintec uses only a very small quantity of that Titanium-Silicon-compound:
1-2 mg/cm² = approx. 20-60 mg/boat

=> 15-40 g Al-wire (99,8%) does contain the same quantity of Si as the IWS

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Initial Wetting System – Possible Concern

C) Analysis

No Titanium and Silicon increase in the metallized film could be detected.

The Ti and Si possibly remains onto the shutter before starting metallization

Initial Wetting System – Visualization

a) Video 1: Initial wetting without "Initial Wetting system"

b) Video 2: Initial wetting with "Initial Wetting System"