Initial Wetting System - Introduction

- The initial wetting of an 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 an aluminium.
Initial Wetting System – Status Quo

• The unused evaporator consists of approx. 65 V. % of Boron-Nitride (BN) which is hard to wet by aluminium.

• Boron-Nitride (BN) is an aluminiumophobic because of the anisotropic crystal structure.
Structure of IMC-Evaporators
Crystal Structure of Boron-Nitride
Wetablity in General

Definition of the "wetting angle of contact $\theta$" on ceramic substrates

$\theta > 90^\circ$: bad wetting

$\theta < 90^\circ$: good wetting
Wetablity in General

At 1000°C, BNL reacts with Al building AlN. Therefore, at >1000°C, you can see the good wettablity of Al on AlN.

Wetablity of aluminum on BN (AlN), Si₃N₄, Al₂O₃ surfaces in dependence of the temperature.
## Vapour Pressure and Evaporation Temperature

<table>
<thead>
<tr>
<th>Vapour Pressure (mbar)</th>
<th>Evaporation Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.33 * 10^-4</td>
<td>920</td>
</tr>
<tr>
<td>1.33 * 10^-2</td>
<td>1140</td>
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</tbody>
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**Comments:**
You see that the liquid Al evaporates before building up the good table AlN at 1000 °C. Therefore the aluminium can be only partially distributed on the evaporator surface.

Evaporation temperature of Al in dependence of the vapour pressure
Some Questions

Why do evaporator boats consist of BN?
BN provides:
- A very good thermal shock resistance
- The right specific resistivity (electrical insulator)
- A good machinable material

What is the reason for good wetting of Al after a certain time of contact?
BN gets decomposed on the hotter, not wetted evaporator surface during metallization. The remaining TiB$_2$ of the evaporator material is a wetting catalyst.
Initial Wetting System - Theoretical Background

Components of the Initial Wetting System

The components of the Initial Wetting System include a combination of alumina and a wetting agent.

Compounds of the wetting agent: Ti and Si.
Initial Wetting System - Theoretical Background

First Heating Up of the Initial Wetting System

$T = 700 - 1000 \degree C$

The wetting agent reduces the wetting angle of contact $\theta$.
This effect helps to distribute the liquid $\text{Al}$.

$T = \text{approx.} 1000 \degree C$

$\text{Al}$ reacts with the BN of evaporator surface building $\text{AlN}$.
$\text{Al}$ wets $\text{AlN}$ well.

$T > 1000 \degree C$

The residual $\text{Al}$ evaporates.
The remaining is a thin $\text{AlN}$-layer which covers almost the whole cavity surface of the evaporator.
Initial Wetting System - Theoretical Background

Continuous Wire Feed
The 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.
Initial Wetting System – Possible Concern

有毒性

湿剂是由钛和硅化合物组成的。这两个元素在与食物接触时不是关键的。
Initial Wetting System – Possible Concern

B) Quantities – Calculation Example

In a 99.8% Al-wire (99.8%) can be found Titanium and Silicon as follows:

Ti = approx. 0.02%  
Si = approx. 0.15%

Sintec uses only a very small quantity of that Titanium-Silicon compound:

1 to 2 mg/cm² = approx. 20 - 60 mg/boat

=> > 15 - 40 g Al-wire (99.8%) does contain the same quantity of Si as the IW System.
Initial Wetting System – Possible Concern

The Titanium and Silicon increase in the metallized film could be detected.
The Ti and Si possibly remain on the shutter before starting metallization.
Initial Wetting System – Visualization

a) Video 1: Initial wetting without

b) Video 2: Initial wetting with

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