

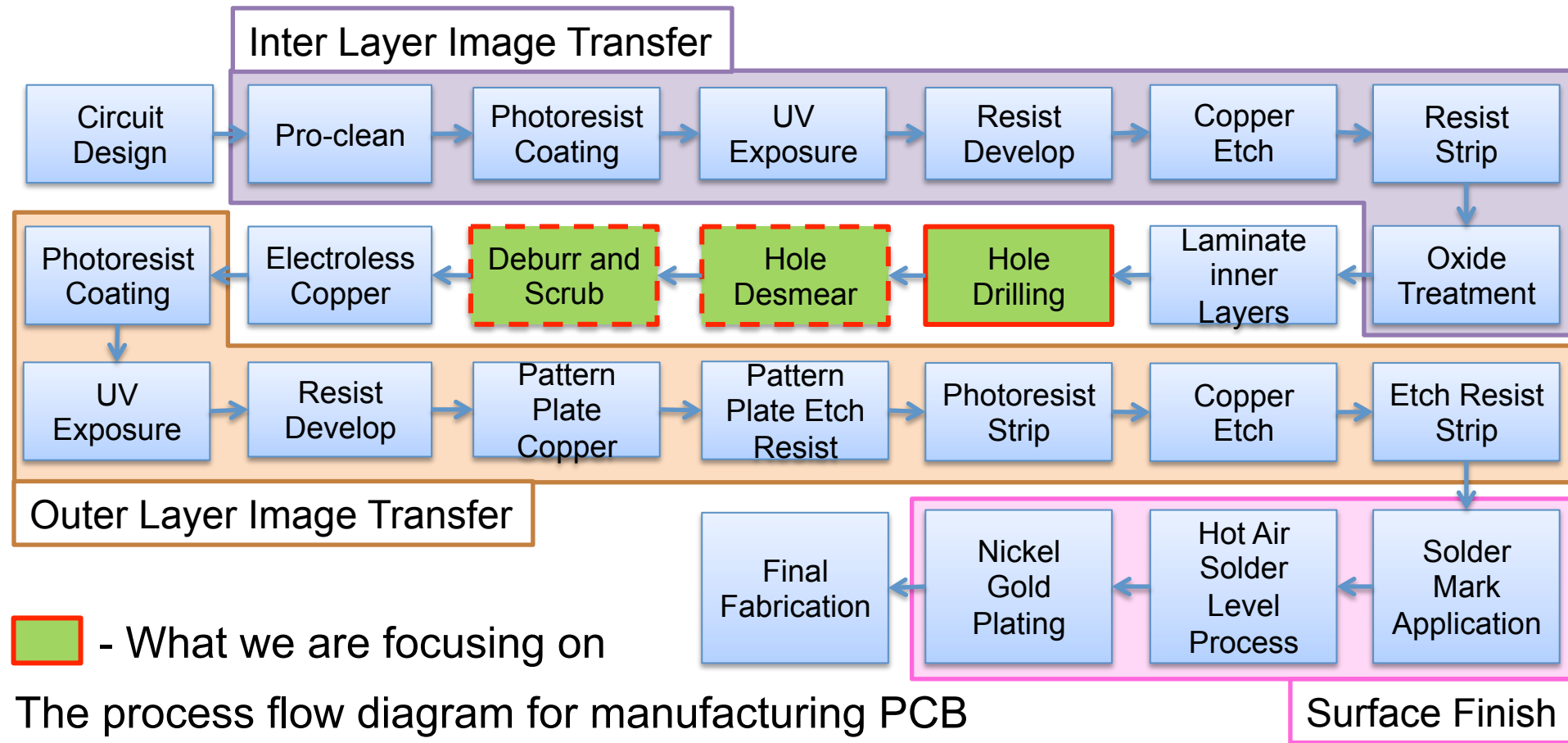
# Drilling Burr Minimization and Energy Saving for PCB Production



Funding Sources: Korea Institute of Industrial Technology

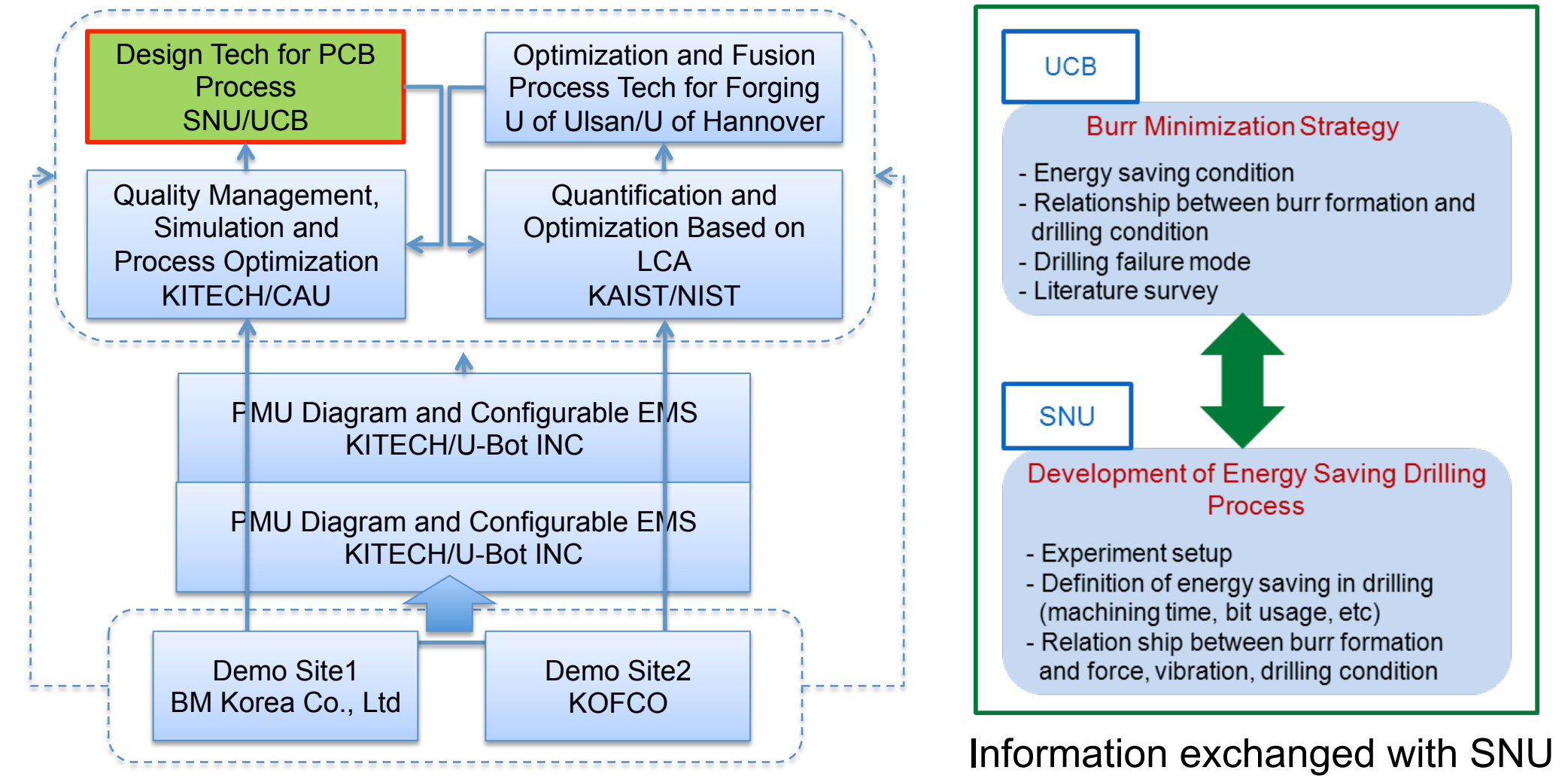
## Motivation

- The hole drilling step is important in the manufacturing of Printed Circuit Boards (PCB). It influences the shape of burrs and the deburring process. Minimizing drilling burr can reduce effort and time for deburring, and therefore decrease energy consumption for the whole process.



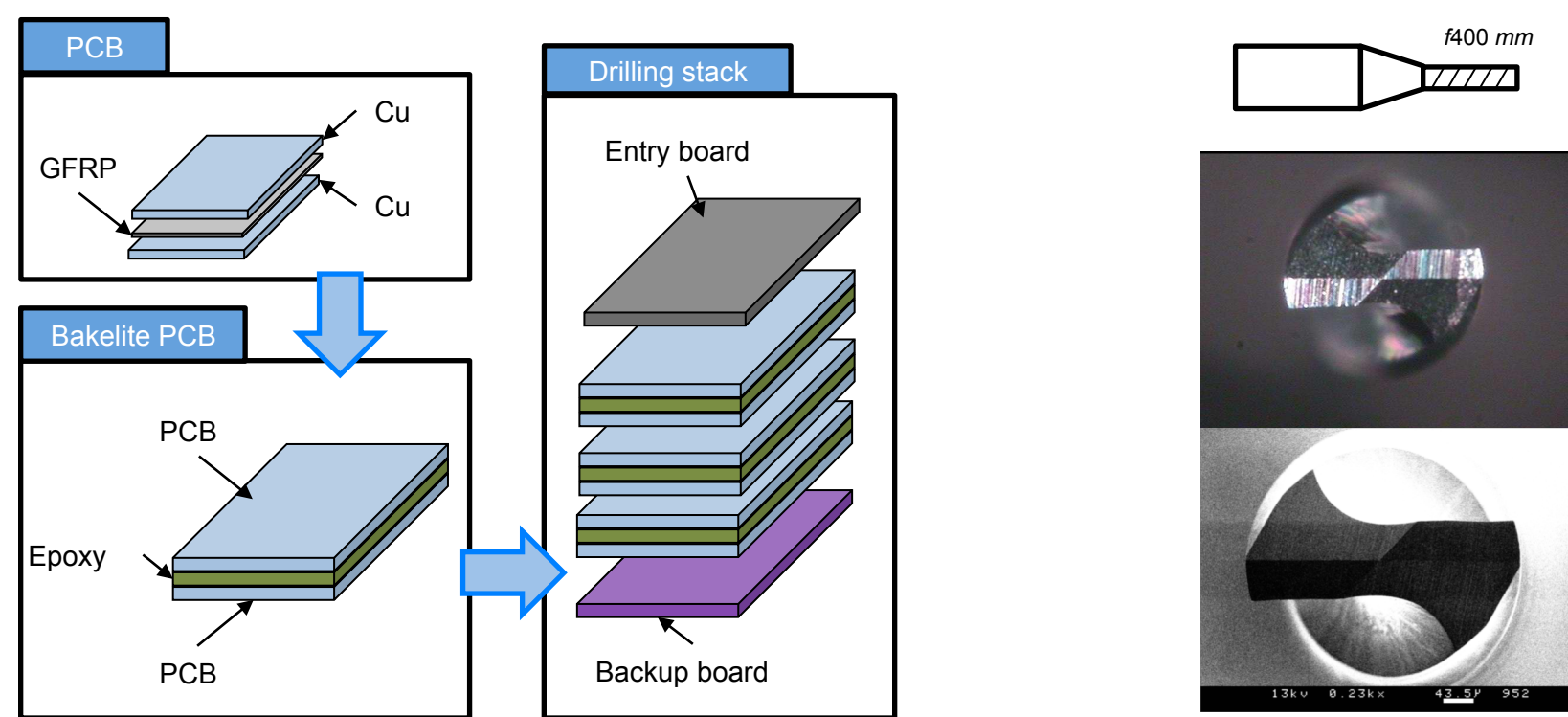
## Information Flow Diagram

- The general goal of the project is to develop a energy-saving manufacturing process for information technology (IT).
- The research consortium:



## Background

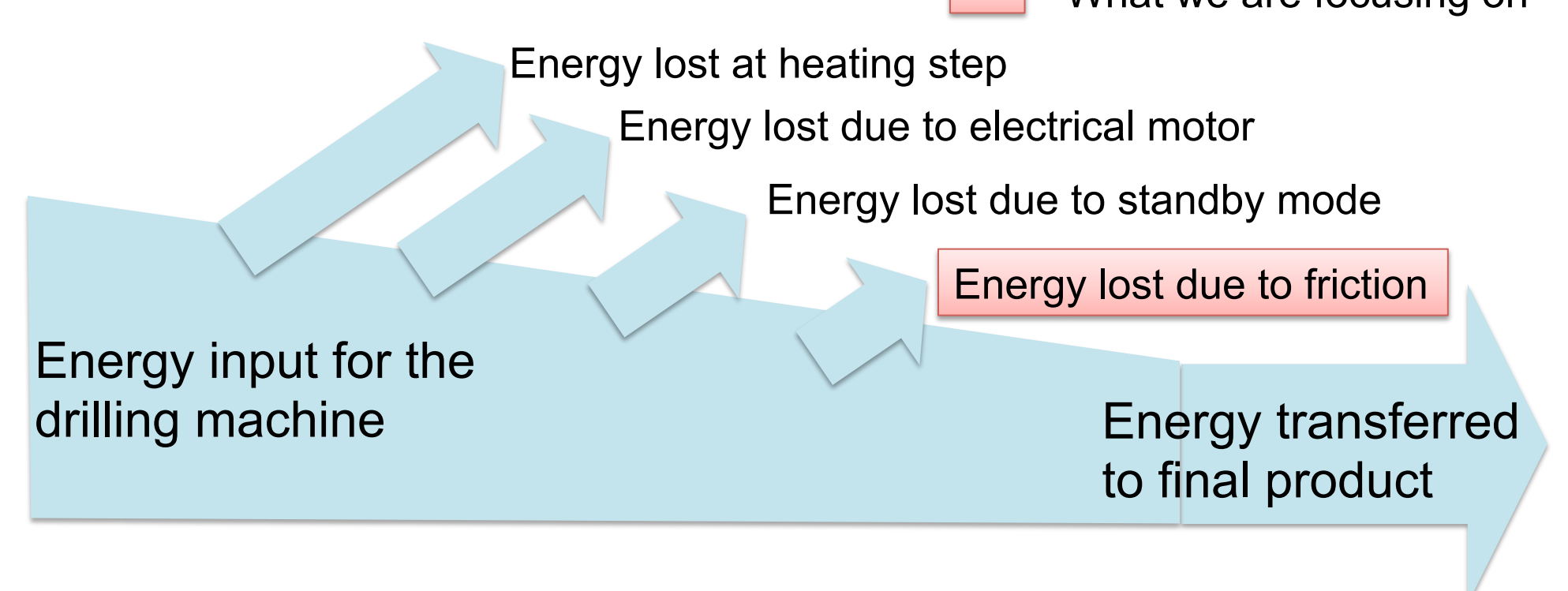
- What is a printed circuit board (PCB)?
- Common drilling tool



- The importance of PCB drilling process
- The global market size of PCB products in 2009 was \$44.4 billion and is projected to register about \$76.2 billion by the year 2015. If we can reduce the energy consumption in PCB drilling process, the global PCB market and our environment will be benefited.

## Energy Saving

- Energy flow in PCB drilling machine

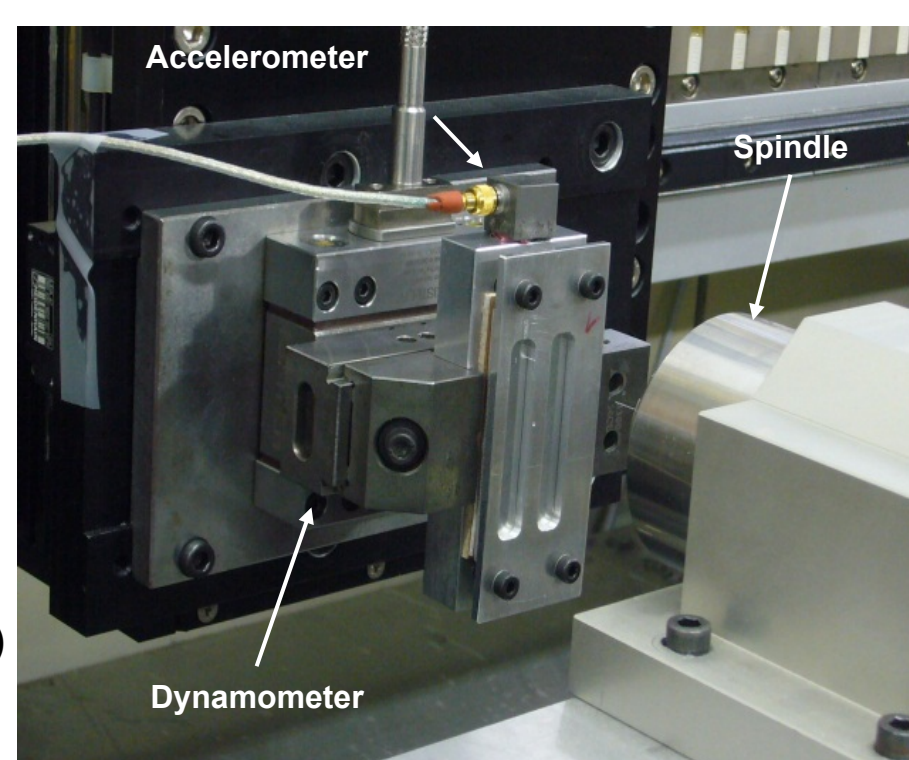


- To achieve energy saving, our strategy are:
  - Minimizing the size of drilling burrs
  - Reducing tool wear
  - Reducing PCB drilling lead time

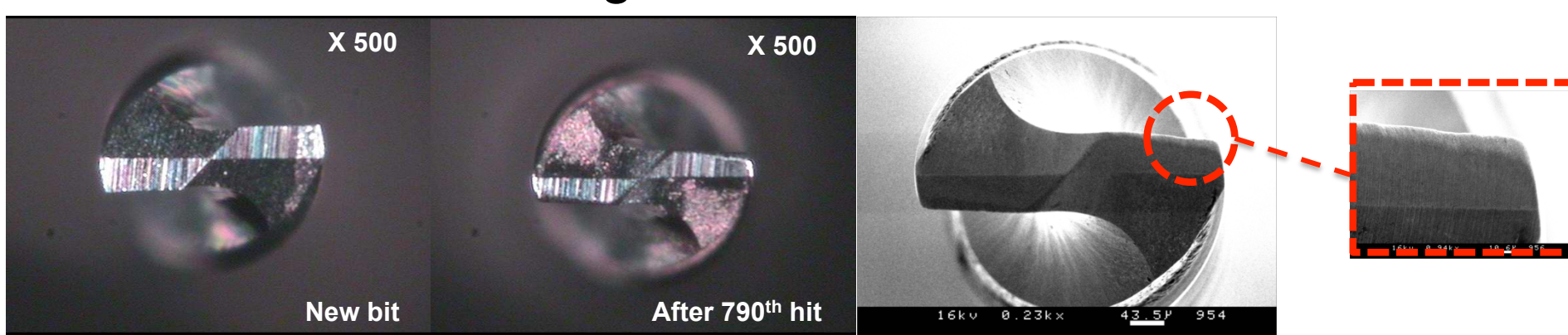
## Experiment Setup

- Process parameters

- Bit diameter: 400 $\mu$ m
- Spindle speed: 90000 rpm
- In-feed speed: 40 mm/sec
- Hits: 790 hits (2000hits)
- Sampling frequency: 20 kHz (low 9 kHz)
- Sampling time: 5 sec (x3)
- Sensors: 3-axis dynamometer, 3-axis accelerometer
- Stacks: 3 layer (recommended by Axis)
- Entry board: Al
- Backup board: wood

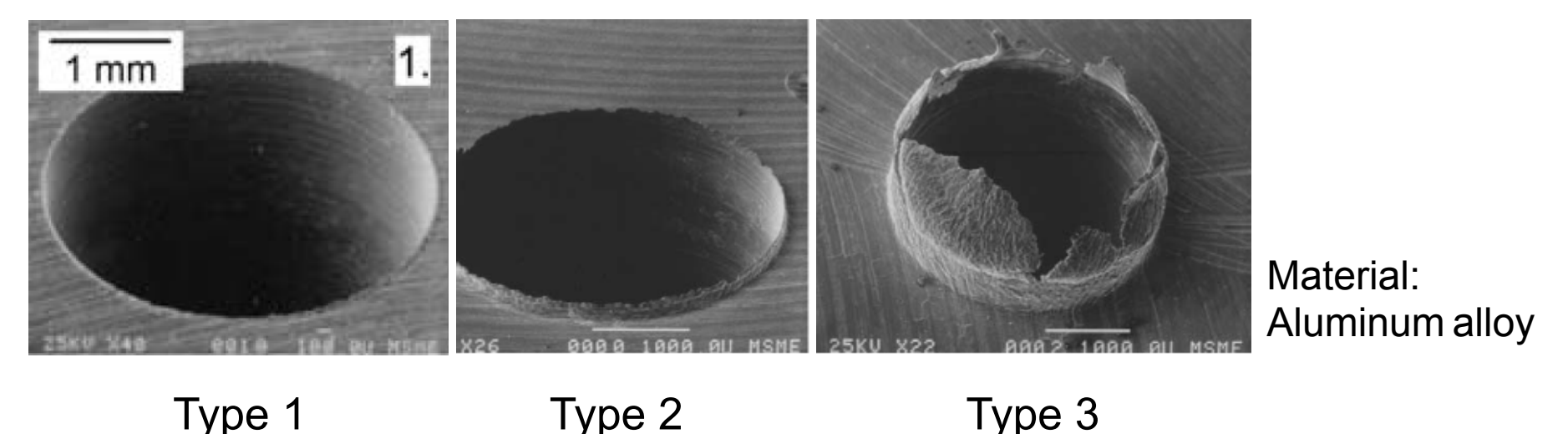


- Tool wear in PCB drilling



## Types of Drilling Burr

- Three types of drilling burr were defined
- Type I – uniform burr with smaller burr height.  
 Type II – uniform burr but with a relatively large burr height.  
 Type III – crown burr which has no drill cap.

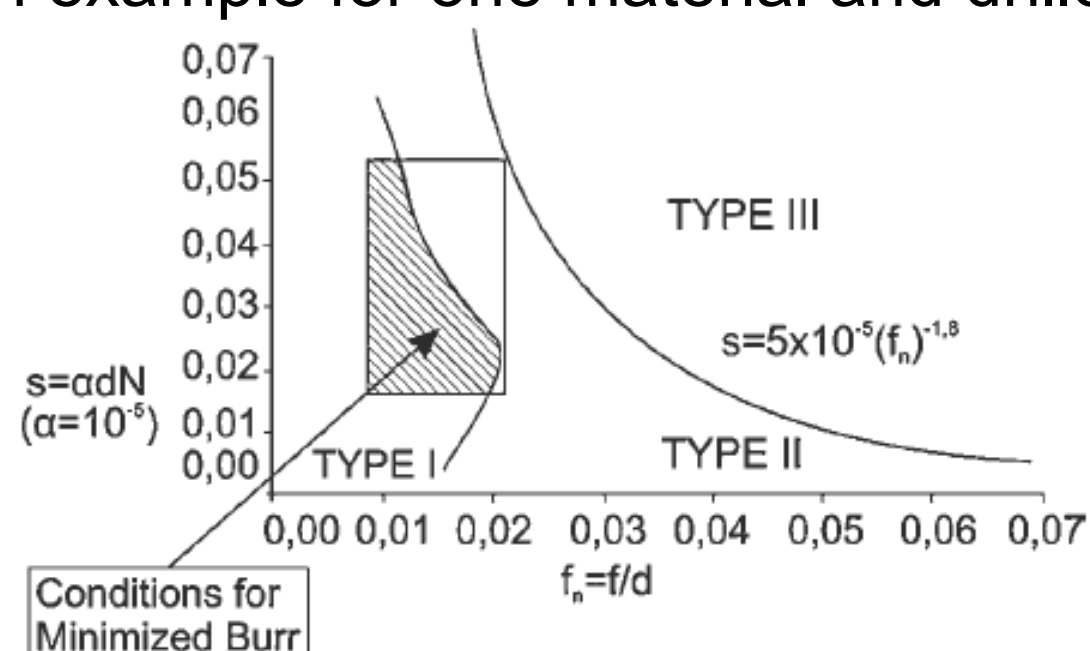


- Based on the definition, we aim to develop the Drilling Burr control chart (DBCC) for PCB by varying the drilling conditions.

Picture Source: Kim J, Min S, Dornfeld D (2001) Optimization and Control of Drilling Burr Formation of AISI 304L and AISI 4118 Based on Drilling Burr Control Charts. International Journal of Machine Tools & Manufacture 41(7):923-936.

## Drilling Burr Control Chart

- A DBCC is proposed as a tool to assist prediction and control of drilling burr under given drilling conditions.
- Here is an example for one material and driller combination.



- Type 1 burr is smallest and preferred. To minimize the drilling burr, the rectangle points out the generally recommended ranges of cutting parameters.

Picture Source: Min S, Kim J, Dornfeld DA (2001) Development of a Drilling Burr Control Chart for Alloy Steel AISI 4118. Journal of Materials Processing Technology 113(1-3):4-9.

## Future Work

- Developing the drilling burr control chart for PCB
- Analyzing relationships among process parameters and energy
- Reducing PCB drilling lead time
- Constructing energy saving knowledge
- Increasing the energy efficiency for drilling
- Constructing information database of PCB drilling