INTT Bus-Extender R&D

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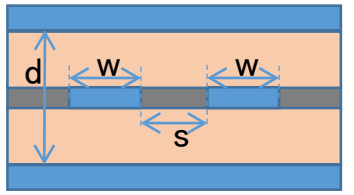
Bus extender status :

- What we learned from 1st prototype
  - Signal transfer performance and line-space control are OK from 1st prototype
- Study on remaining issues
  - Peel strength
  - Through hole for long FPC
- Prototype production

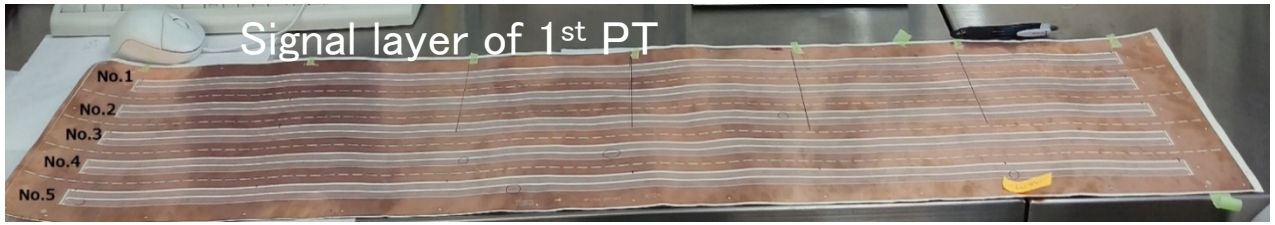
Electrical and mechanical performance in 1st prototype

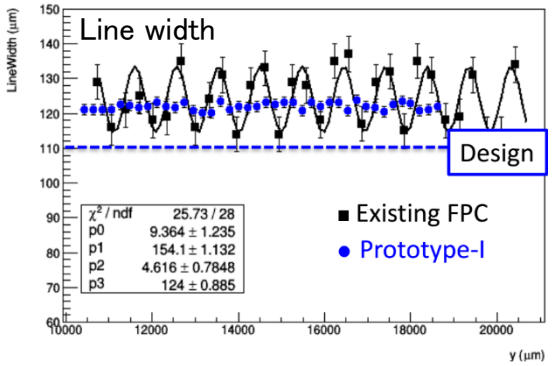
- 1st prototype to test long-dense FPC
  - Length : 1.2m, 60 pairs with140um line & space
  - Zdiff = 100Ω with strip line structure（3 layers, signal layers covered by GND ）
  - LCP(Liquid Crystal Polymer) because of small di-electric tangent, good for low signal loss

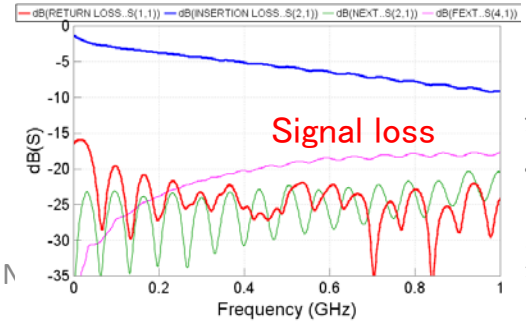
Layer structure for 1st PT (strip line)

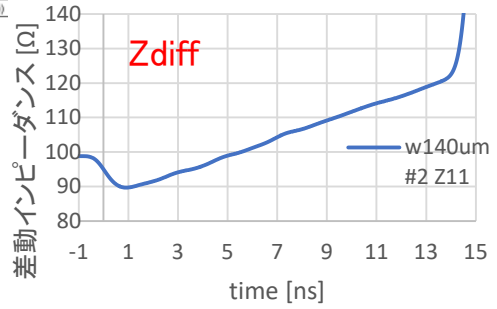


- Performance test
  - Mechanical
    - Line&space measurement
    - Peel strength
  - Electrical (signal transfer)
    - Signal loss with frequency
    - Zdiff
    - Eye diagram
  - All the results are passed within acceptable range except for..
    - Issue: peel strength
  - Remaining issue
    - peel strength
    - Through hole on long FPC (company has the machine)





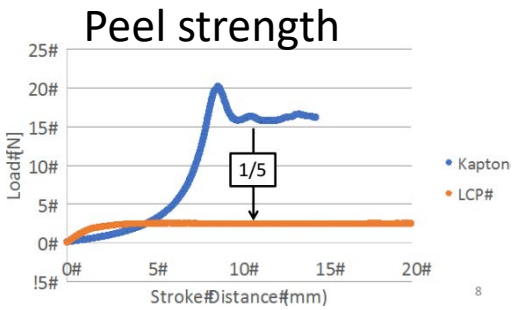




Eye diagram

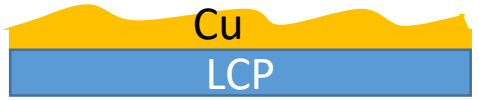
Improving peel strength

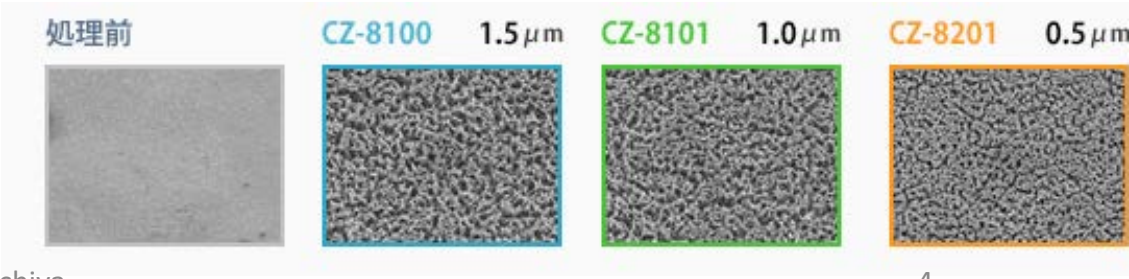
- Peel strength is small from previous study (3N) compared with Polymide
- Tsuruta-kun is working to improve the strength
  - Ichino-kun recently joined



- Several ways to make stronger :
  - Use other LCP products: Manufacturer (Panasonic)
    - Provides LCP with rough Cu surface
  - Chemicals can make rough
    - Discuss with MEC to make some test samples
  - Test samples were measured

Make Cu surface rough for more adhesive area

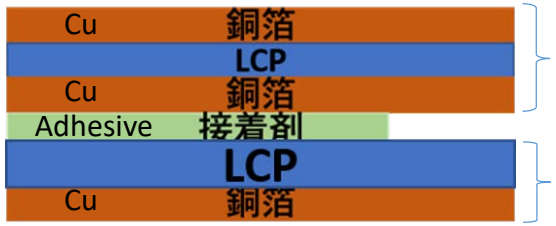




Peel strength measurement

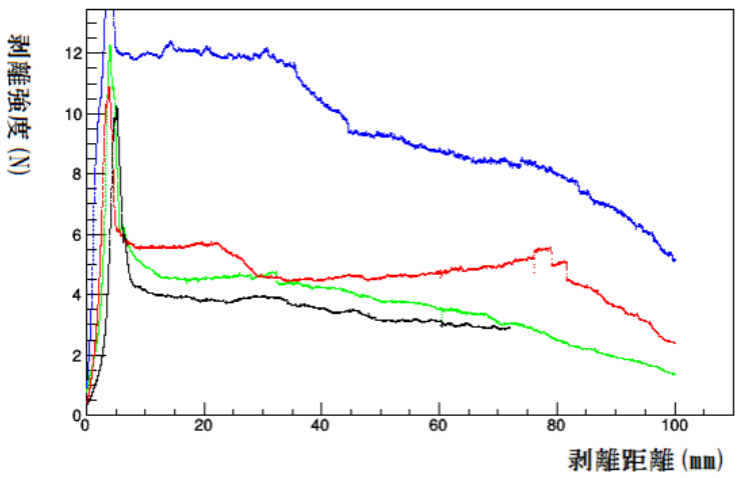
- 3 test samples
  - Rough surface LCP by manufacturer
  - Chemical to make rough with RS-LCP
  - Chemical to make rough with Polymide as a reference
- Result
  - Peel strength is slightly higher (3 -> 4~5N)
    - No Chemical effect is seen
  - Polymide is 2~3x higher
- After this test, we realized
  - FPC is broken by test. Unexpected layer is peeled
    - Adhesive layer is expected to be peeled but..
    - Thickness of the peel area (Cu, LCP) is measured and confirmed
    - 4~5N can be the strength between LCP and Cu (not Cu + Adh.)
  - peel strength of LCP material is weak
    - 10N/cm in Catalog which is inconsistent with our result
    - Consulting with Manufacturer
      - Gather the information of the production process (temperature during gluing with presure)

Layer structure



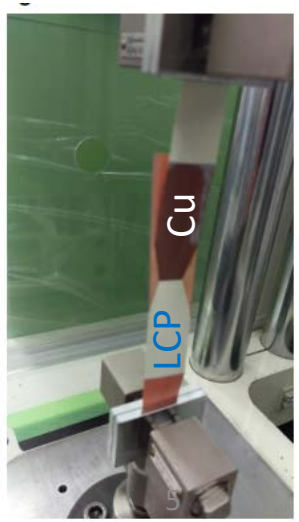
Grab and pull up

Grab and pull down



黒 A1① Chemical
赤 A2③
緑 B① Just RS
青 C① Polymide

Where it peeled by test

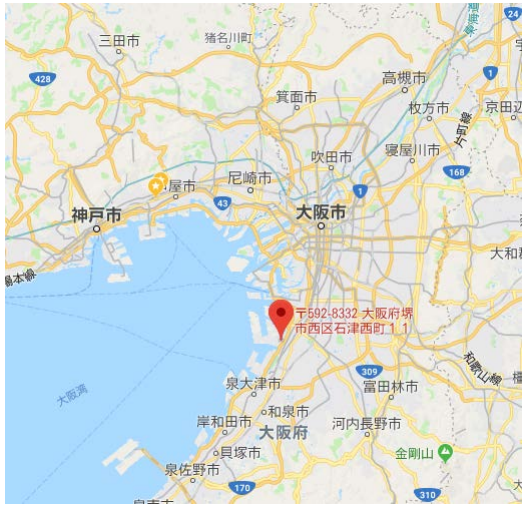


Through hole R & D for Bus Extender

- There are some difficulties to make Cu plating with log FPC
  - Plating machine for long FPC is not usually available in the market
    - We found a company which has ability to make Cu Plating with long FPC
  - The company doesn't have experience with LCP (Liquid Crystal Polymer)
- We need some test production for several purposes
  1. Check if Cu Plating with single layer LCP material
     - DONE (by that company). It was successful
  2. Check if Cu plating with multi layer FPC
     - Integrity of the though holes needs to be tested.
       - Thermal shock test to the through hole
  3. Check if Cu plating with long FPC (2^{nd} prototype)

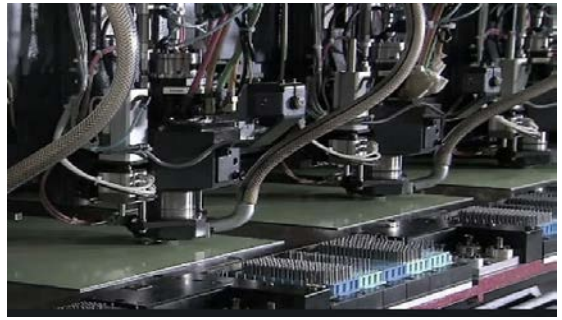
Cu Plating company

- TAIYO-KOSAKUSHO company, Japan
  - Plating techniques not only for PCB (FPC) but for pad of LSI Chip, tiny surface mount chip, rust prevention(Ni), plating with Plastic



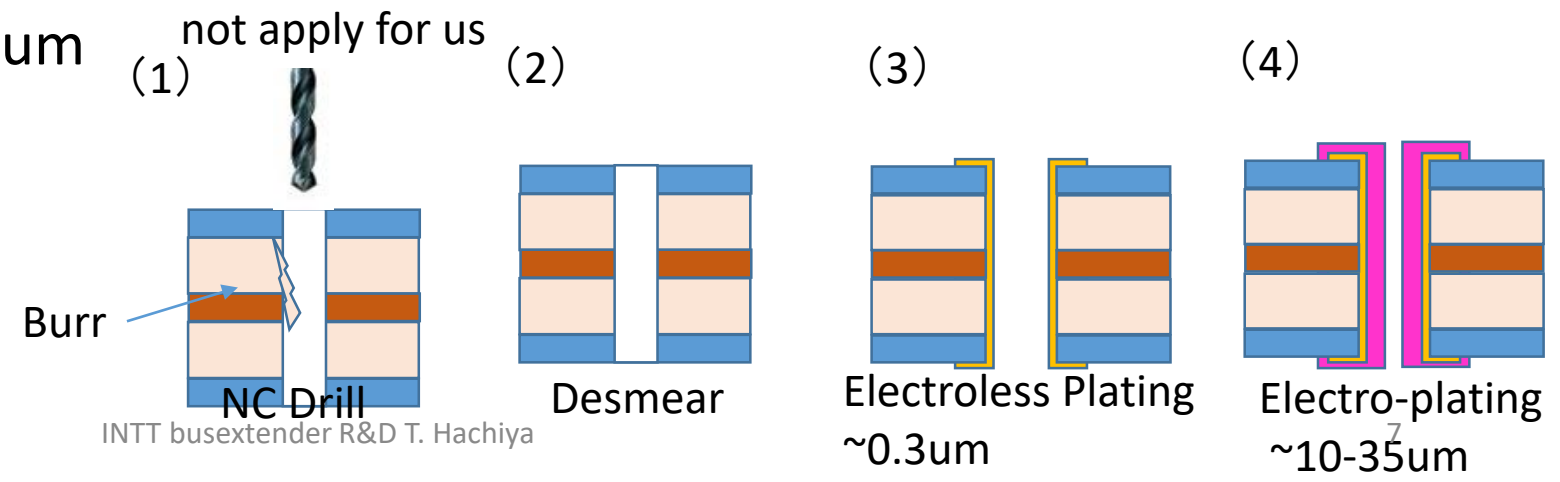
- Making through hole
  1. Drill holes on FPC
  2. Desmear treatment
     Remove burr by chmemical
  3. Electroless Cu Plating w/~0.3um thick
  4. Electro Cu plating w/~10~35um thick
     - Make Cu plating thicker

NC drill



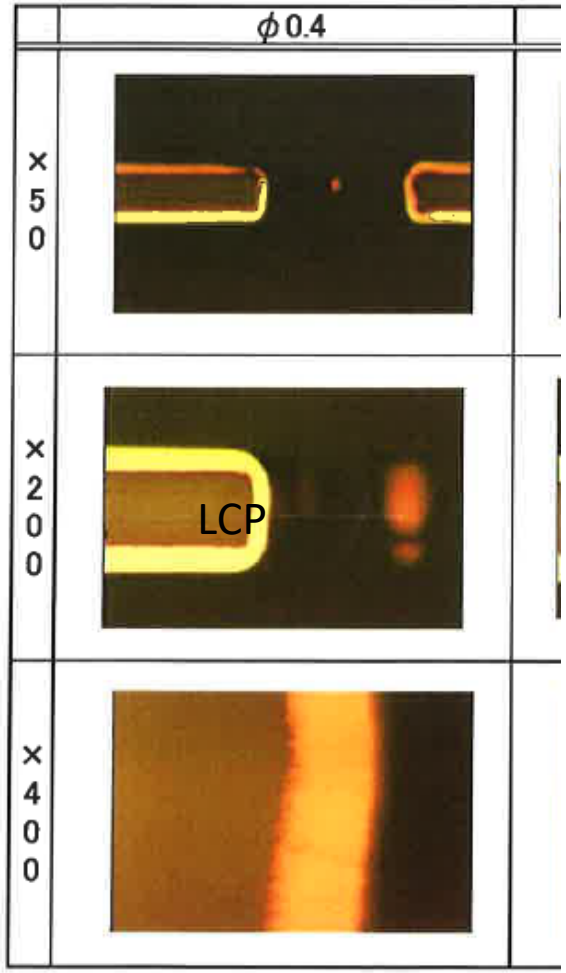
Electro Cu plating

not apply for us



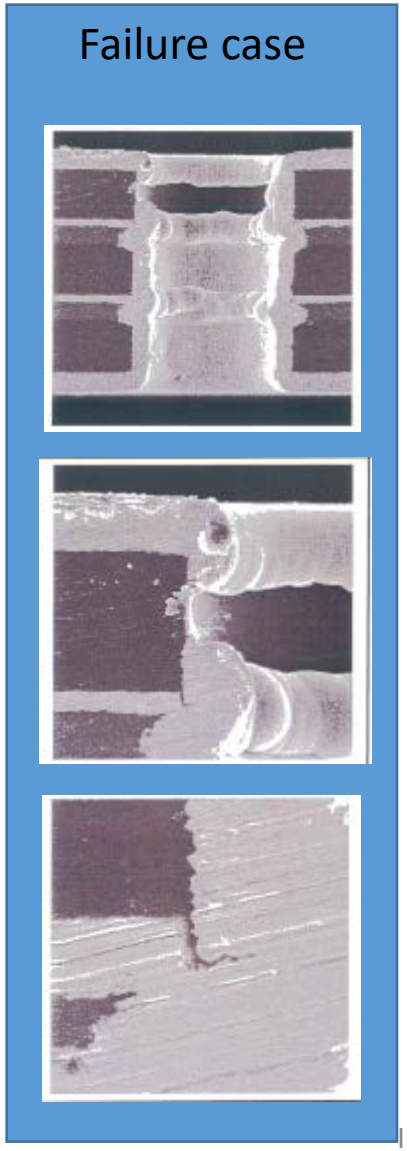
1st Cu plating test with single & multi layer LCP

Cu plating for single LCP

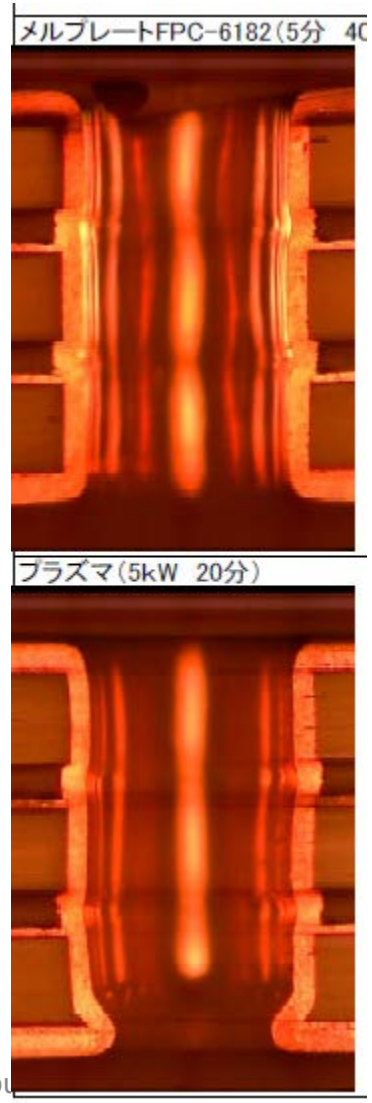


Cu plating for multi layer

Failure case

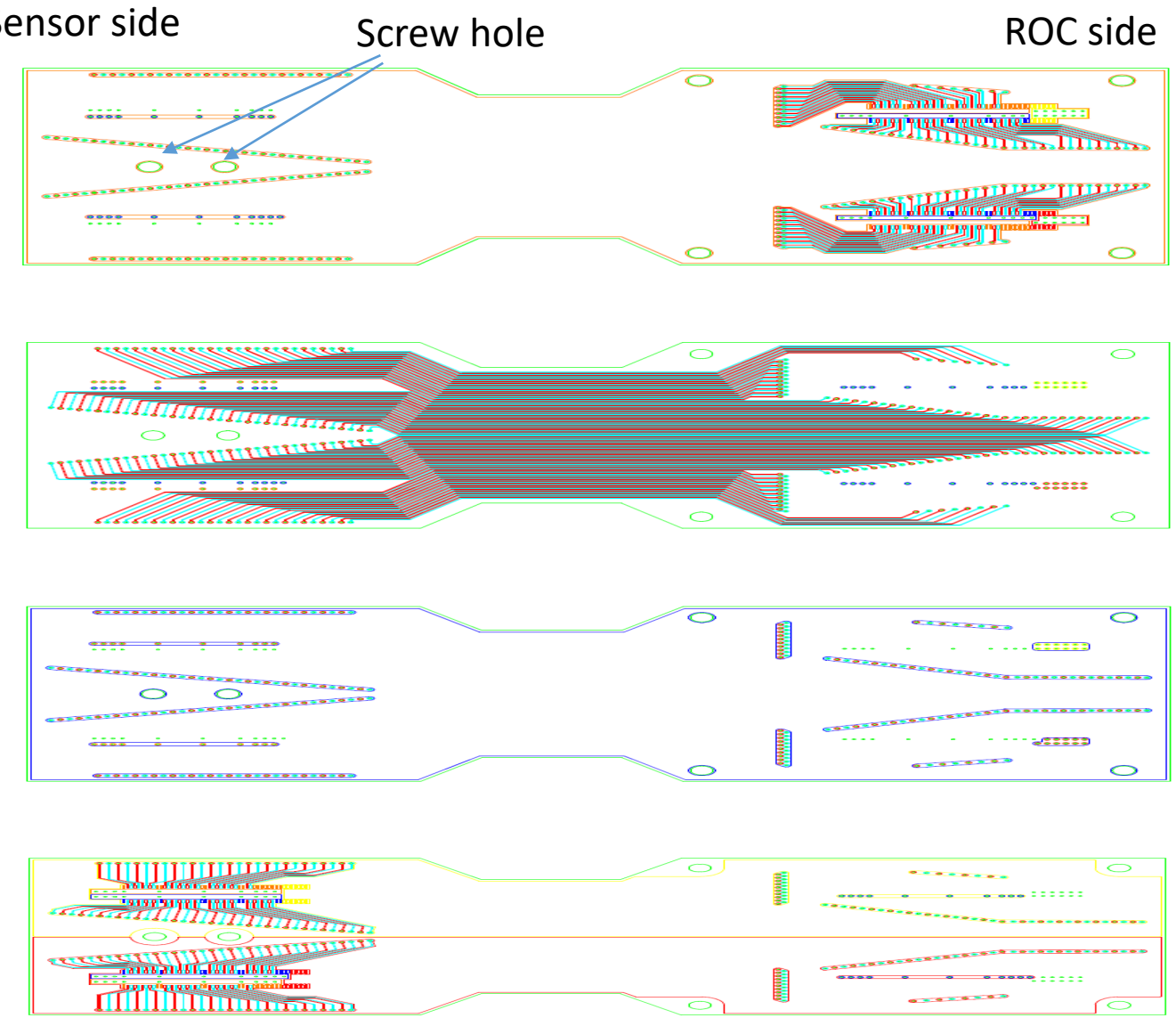


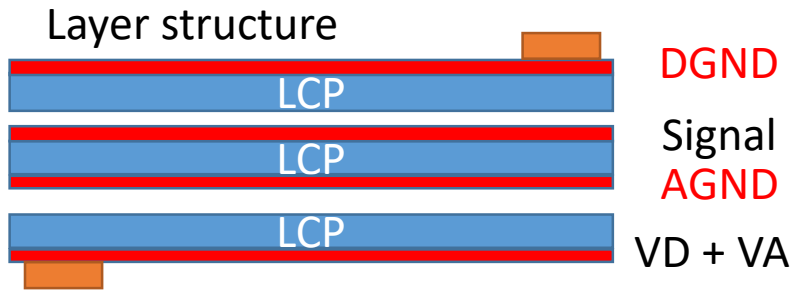
Successful



- In single layer test, Cu plating covers uniformly
- In 1st multi-layer test, the plating was failed
- In 2nd multi-layer test, it was successful by using additional treatment before electroless Cu plating
  - Make surface rough by plasma and/or chemicals
  - Hole is made by TAIYO co. , not PrintDensi co. which is not the way for actual production.
- Another test is planed before proto-type production
- Thermal shock test is needed for long-time use

Design for 2nd prototype (possible production version)



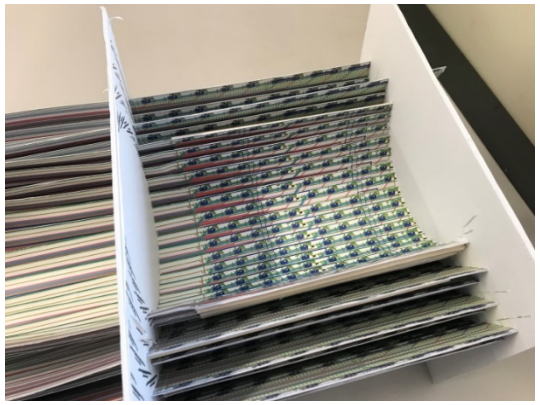


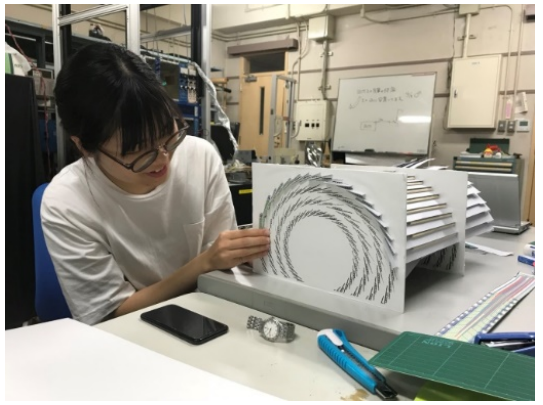
- 4 layer structure (
  - Power(VA, VD)
  - AGND
  - Signal
  - DGND
- Through hole is used to connect inner to outer layer
- Screw hole is prepared
- Connector is placed upside down for sensor side and ROC side
- Design is completed. Production is in progress
  - Production design is going by PrintDenshi co.

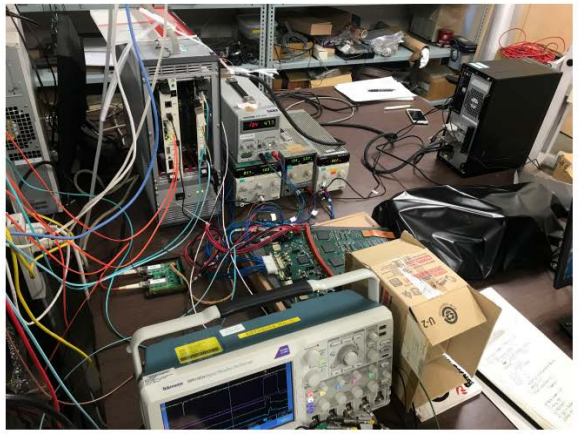
Other activities

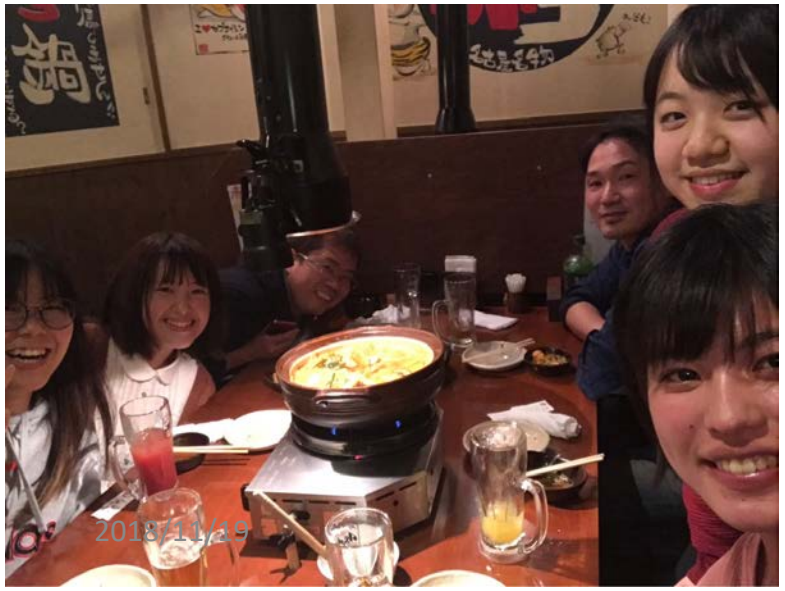
- Mockup is made by Suzuki-san, Isshiki-san, Kureha-san, Sugino-san (undergrad.) in Nara
  - Can visually see how tight the space is

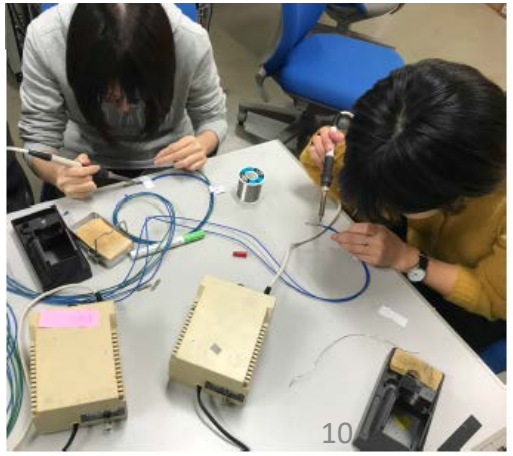
- INTT test bench is built at Nara WU
  - Yorito came to Nara to help setting up the bench and teach students. THANKS!!!



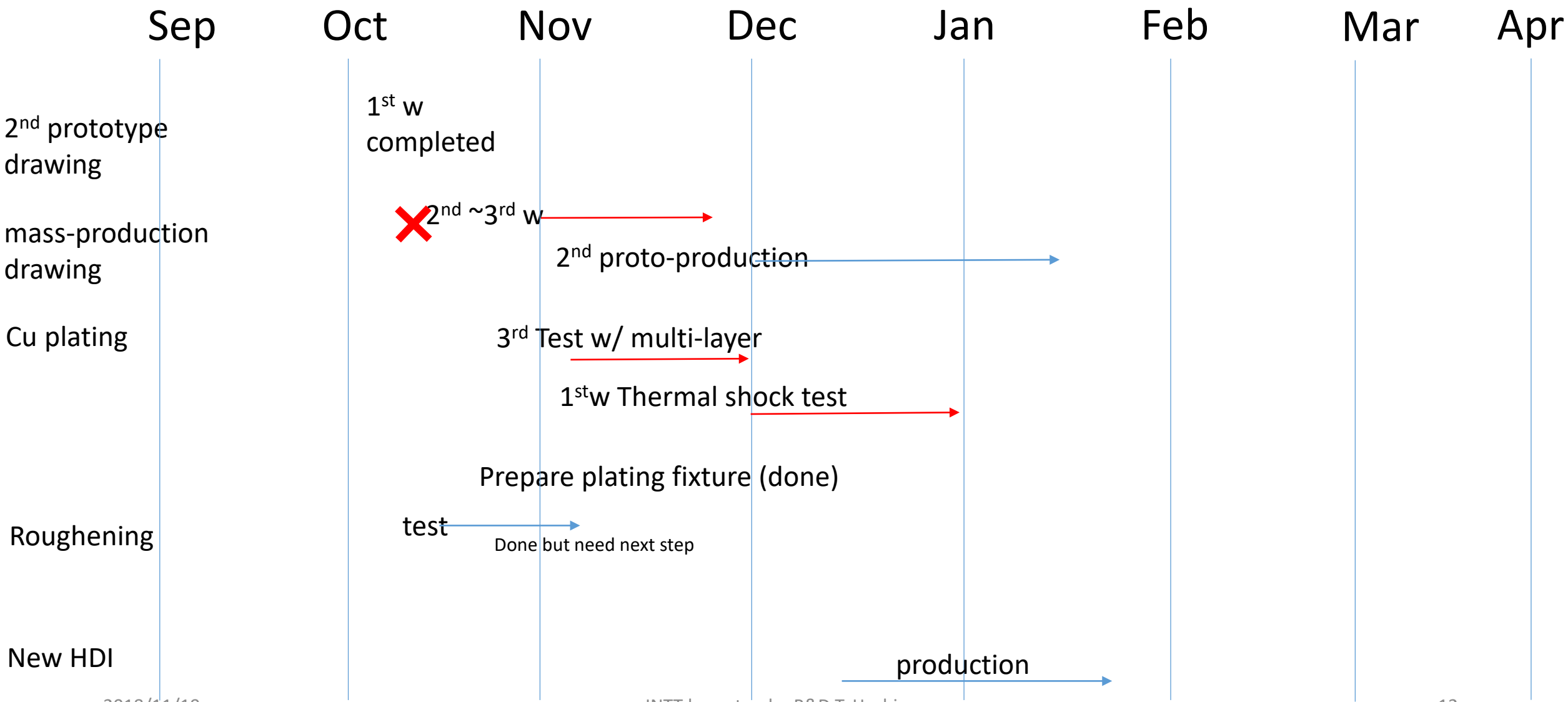






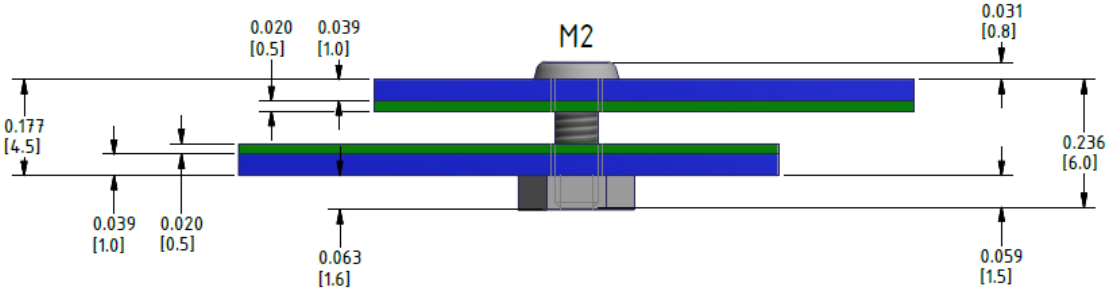


Tentative Schedule

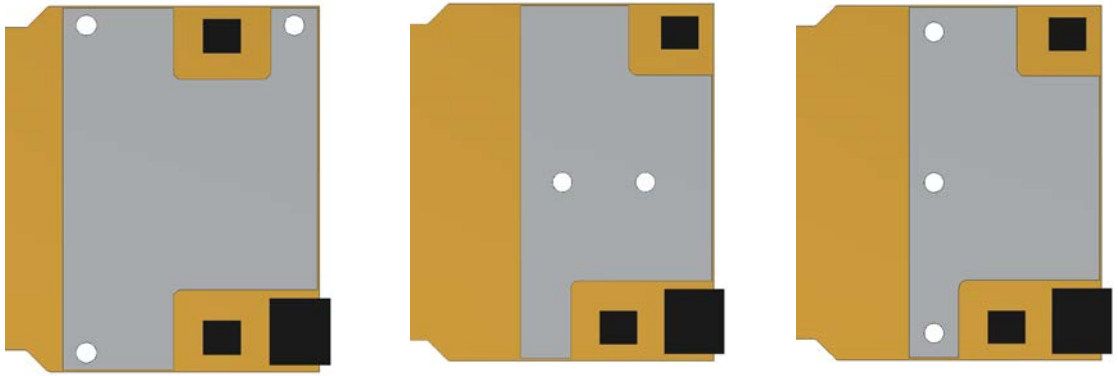


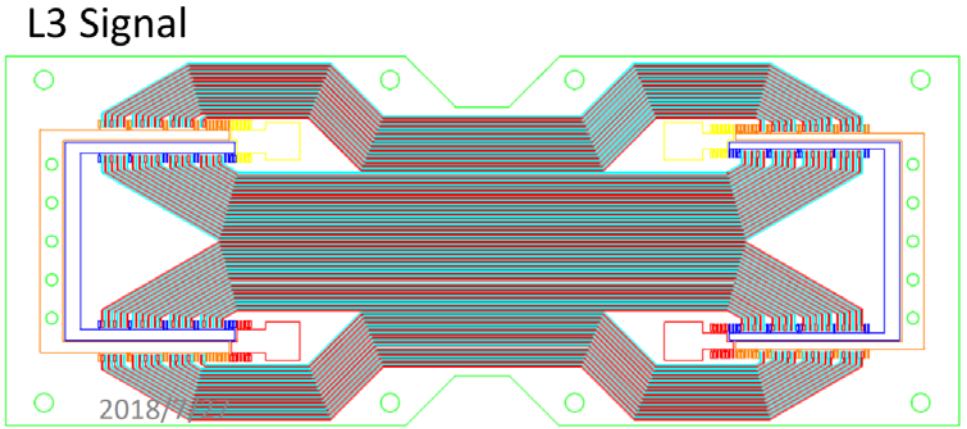
ネジの位置とサイズ

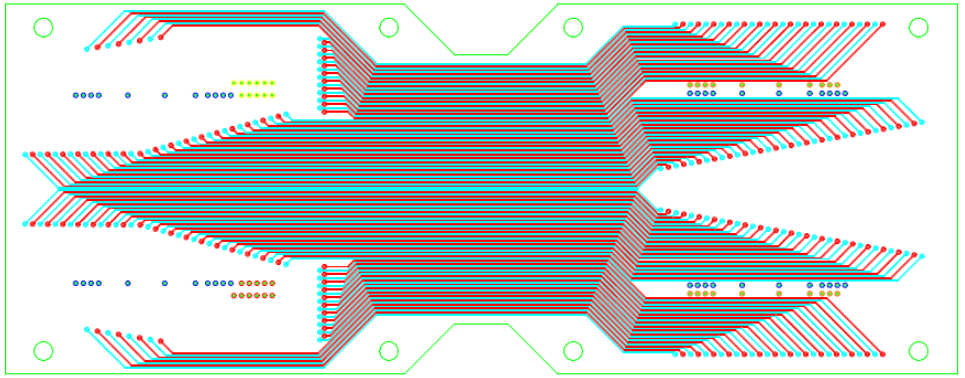
- HDIとエクステンダの固定： ネジ
  - M2サイズ、ナットで固定



- ネジの位置

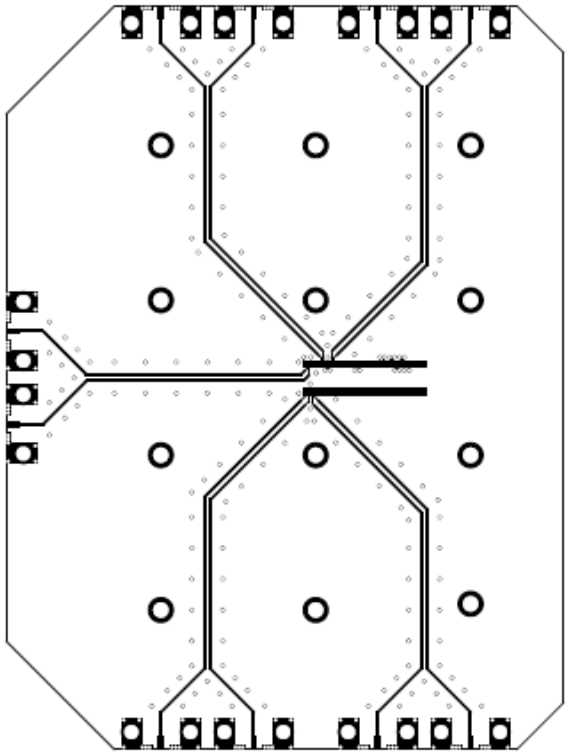






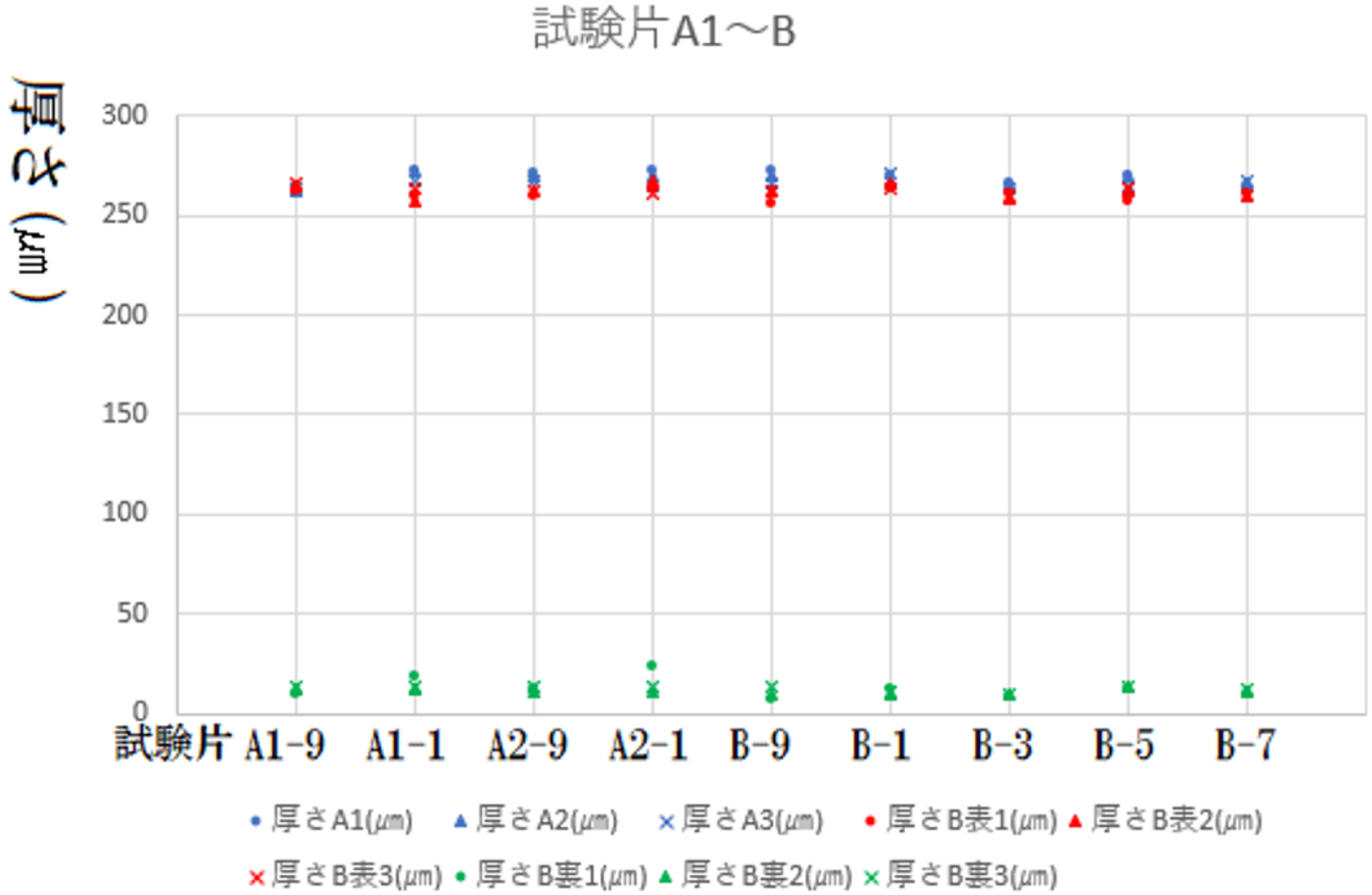
試作エクステンダの評価用基板

- 評価用信号取り出し基板の設計（近藤さん）
  - 取り出した信号をオシロスコープやネットワークアナライザに接続し、 電気特性を測定する
  - スルーホール有版のエクステンダに対応
- 以下の5ペアを選択
  - ① 基板端による影響の評価
    - DS1_CP01_OUT0(P/N)【〇】
  - ② 隣接層間（L3/L4）におけるクロストークの評価
    - DS1_CP04_OUT0(P/N)【〇
    - DS1_CP05_OUT0(P/N)【□】
  - ③ 同層内隣接線路によるクロストークの評価
    - DS1_CP01_OUT1(P/N)【△】
    - DS1_CP01_OUT2(P/N)【△】



測定結果①

- 試験片A1,A2,Bの結果は以下のようになった。
- いずれもLCPと銅が剥離したことが確認できた。



セミアディティブ法対応　LCPフィルムへの無電解銅めっきプロセス

トップLECSプロセス

Electroless Copper Plating Process to LCP Films Applicable for SAP

TOP LECS PROCESS

- 高周波高速伝送に適したLCPフィルムへのめっきが可能
- 全工程湿式プロセスであり、Roll to Roll処理により両面を一括でメタライズ可能
- セミアディティブプロセスに対応
- 優れた密着性が得られる

- Realize plating to LCP films suitable for high-frequency, high-speed transmission
- All steps : Wet process
- Metallizing both sides at once by Roll to Roll treatment
- Applicable for SAP
- Excellent in adhesion

全工程湿式プロセス
All steps:Wet process

表面改質 Surface reforming	トップLECSプリコンディション TOP LECS PRECONDITION
コンディショニング Conditioning	トップLECSコンディショナー TOP LECS CONDITIONER
プリディップ Pre-dipping	トップLECSプリディップ TOP LECS PREDIP
触媒付与 Catalyzing	トップLECSキャタリスト TOP LECS CATALYST
活性化 Accelerating	トップLECSアクセレーター TOP LECS ACCELERATOR
無電解銅めっき Electroless copper plating	トップLECSカッパー TOP LECS COPPER

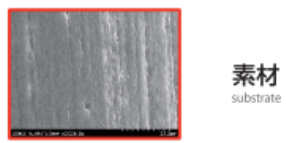
トップLECSプロセス処理工程

LCPフィルムに直接無電解銅めっきが可能

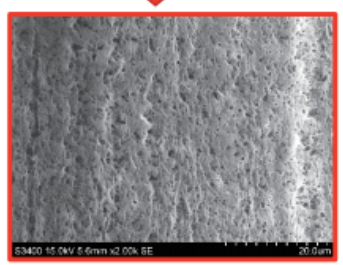
TOP LECS PROCESS, Treatment process

Realize direct electroless plating on LCP films

高速伝送に適した低粗化プロセス
Process for low Ra materials, suitable for high-speed transmission



素材
substrate



表面粗化後
After Surface roughening

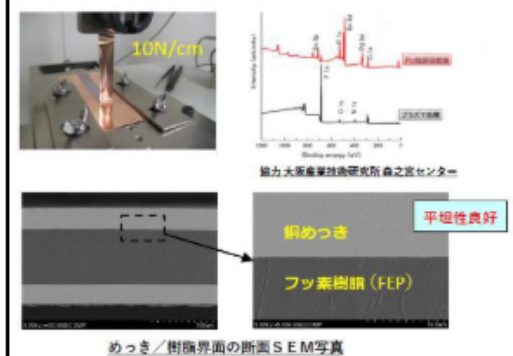
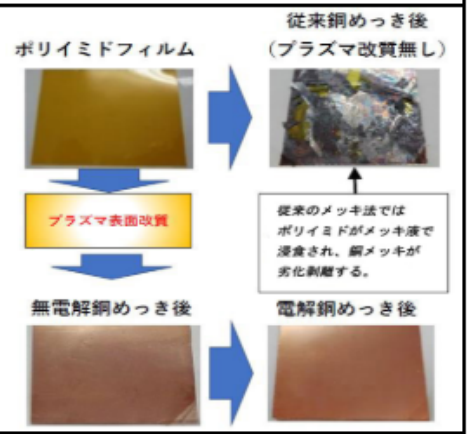
Ra=102~131nm

TECHNOLOGY

- ▶プラズマについて
  - ①プラズマとは、、、
  - ②プラズマ装置例
  - ③プラズマ技術利用例
- ▶フッ素樹脂等直接メッキ
- ▶表面改質
  - ①金属
  - ②酸化物粒子
  - ③カーボン粒子
- ▶金属粒子インクの低温焼結

▶ フッ素樹脂等難接着基板への直接メッキ技術

電子技研では、独自開発したプラズマ表面改質技術を用いて、フッ素系樹脂、ポリイミドの表面を改質し、**直接銅メッキができる技術**を開発！

フッ素樹脂への直接銅メッキ	ポリイミドへの直接銅メッキ
プラズマ処理による表面粗化することなく、平坦性良好な状態を確保し、フッ素樹脂（FEP、PFA、PTFE）へのメッキ密着力確保を実現。	従来メッキ法でのメッキ液によるポリイミドへのダメージなく、メッキ密着力確保した直接メッキを実現。
 めっき／樹脂界面の断面ＳＥＭ写真	
フッ素樹脂への直接銅メッキを実現 ピール強度：＞10N／cm （注）PTFEについては、3.0N／cm以上測定不可（耐性要因で、ピール測定時にPTFE内部で破壊してしまう為）	ポリイミドへの直接銅メッキを実現 ピール強度：＞10N／cm