DfR Solutions
reliability designed, reliability delivered

Flip Chip Reliability Issues

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DfR Solutions

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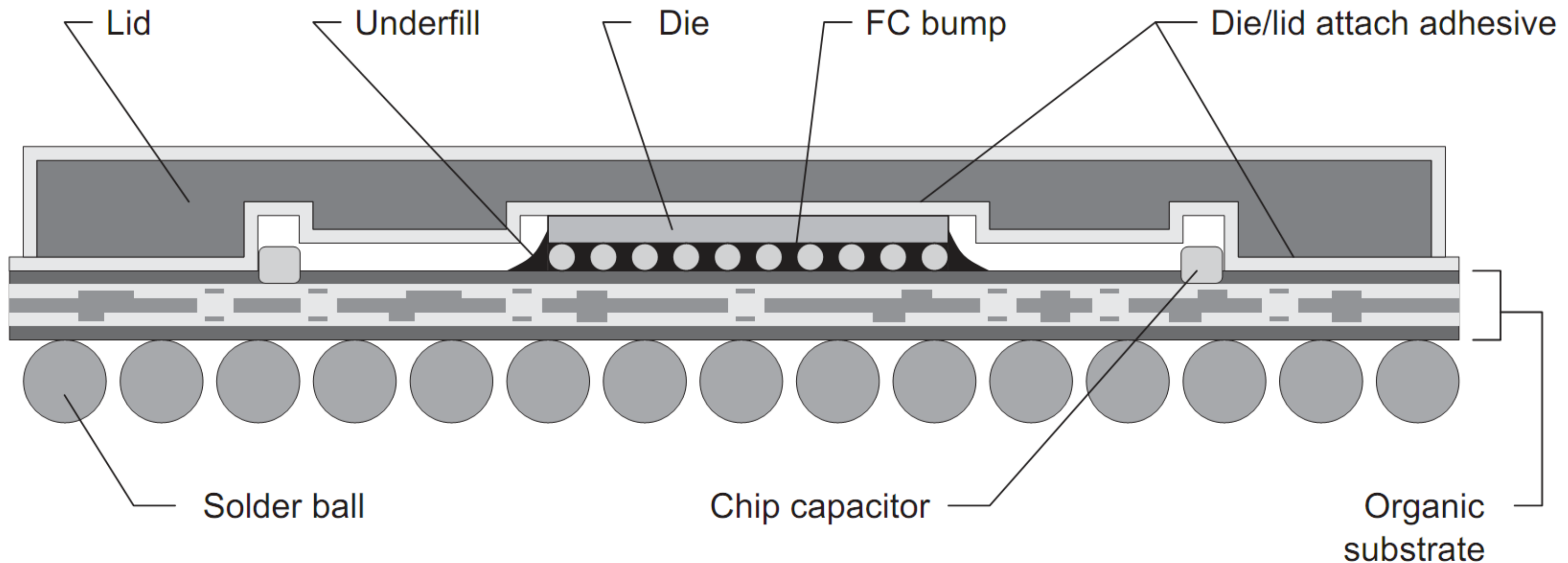
What is a Flip Chip?



- Typical flip chip BGA package with lid
  - Source: Texas Instruments
- Some terminology and jargon:
  - Balls and bumps
  - Board and substrate
  - TIM1 and TIM2
  - Lid and heatsink

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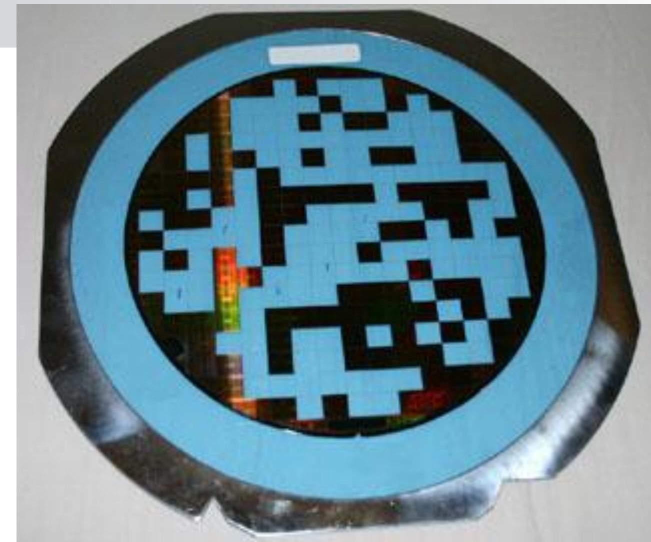
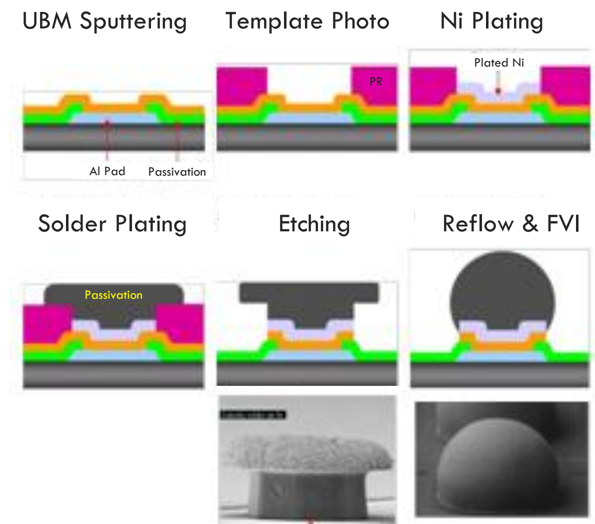
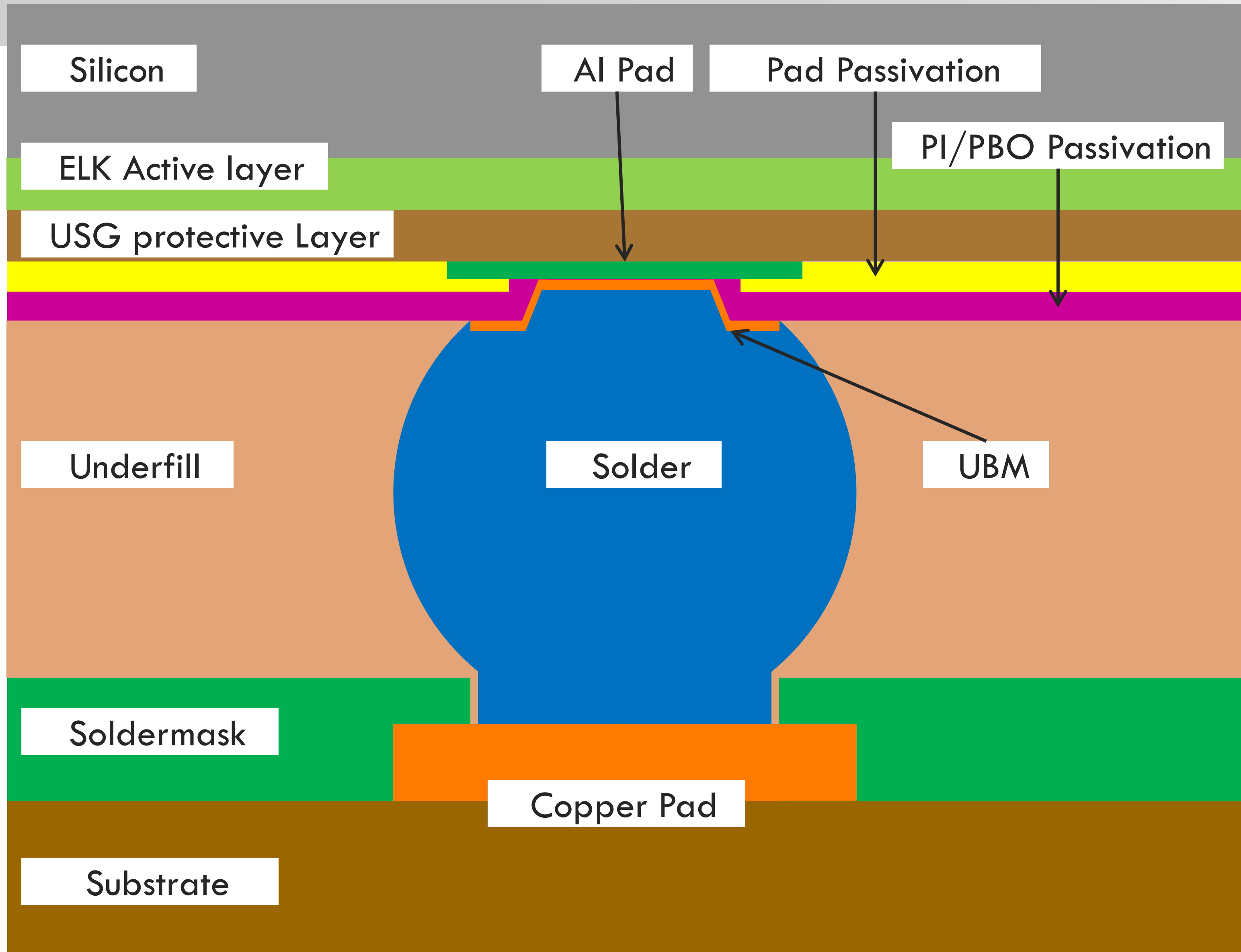
Packaging Silicon

- The active layers are deposited on a silicon wafer in the "fab"
- You get the die from the "fab"
  - Glued to a ringed tape
  - Wafer is diced
- The packaging is done at a "fabless semiconductor" company
  - Create the UBM and bumping
  - Attach chip to substrate
  - Deposit Underfill
  - …many more steps…
- Delivered package
  - Includes BGA balls
- Let's look at the bumps…





Flip Chip SnAg Bump



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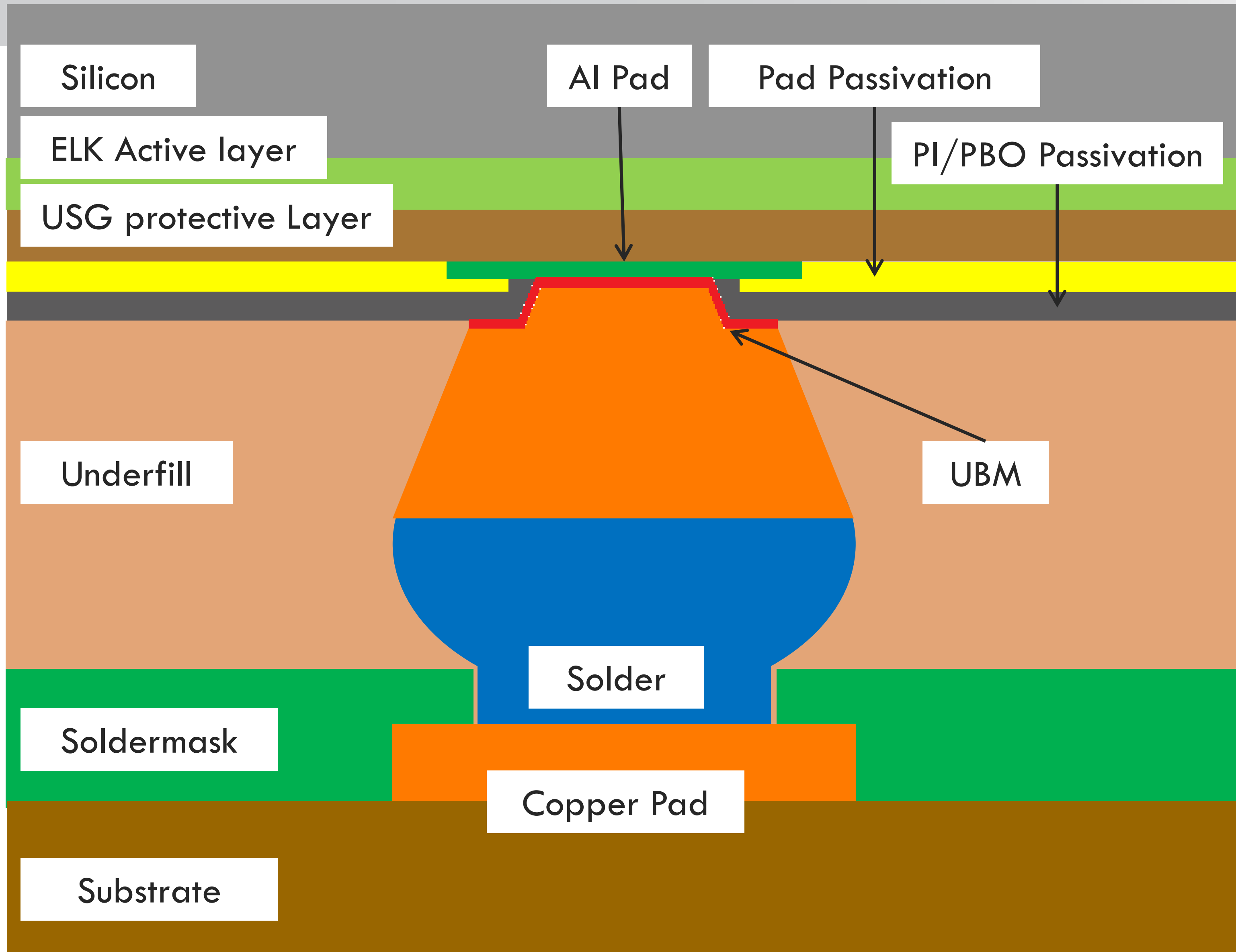
Flip Chip Copper Pillar



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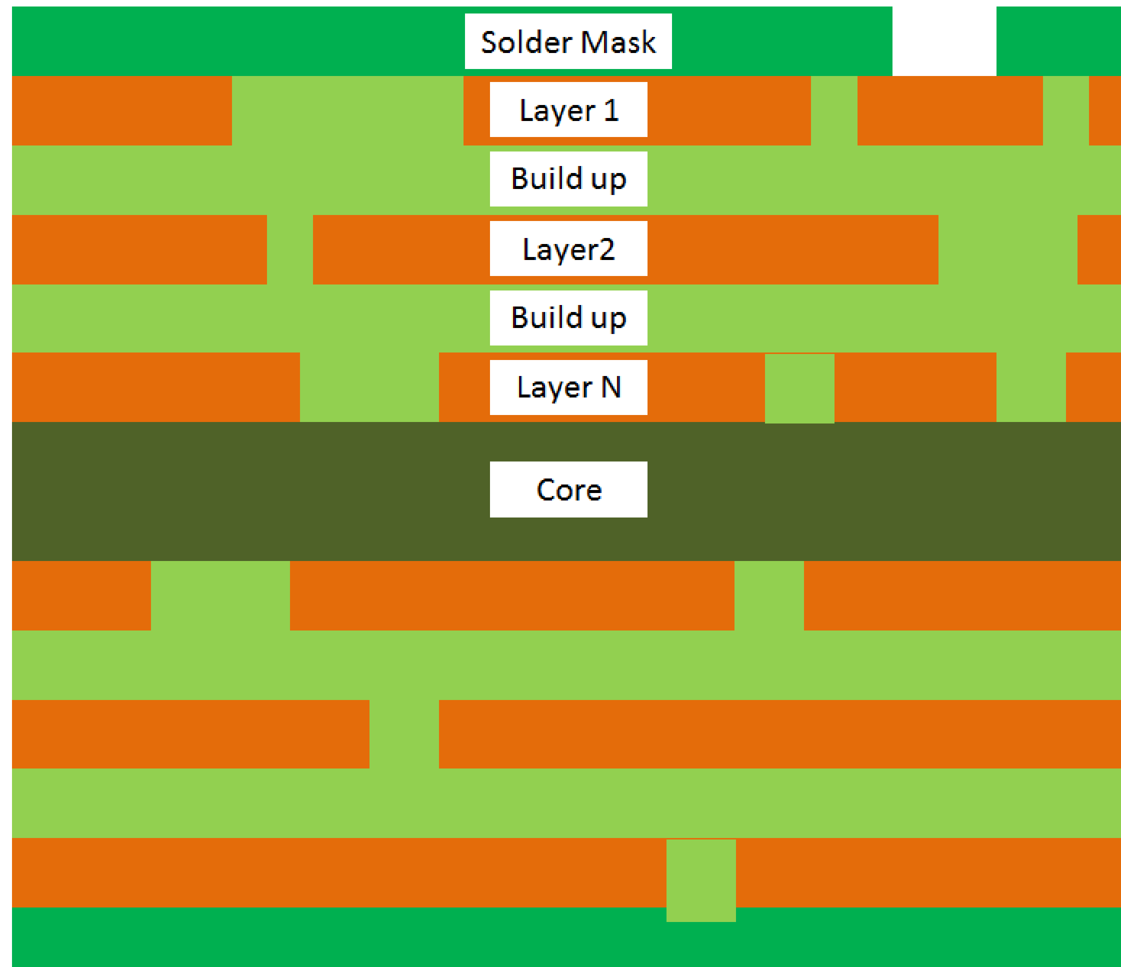
Substrate Stackup

- Stackup is complex
- Materials
  - Core
  - Build up
  - Soldermask
- Interactions
  - Shearing
  - Delamination



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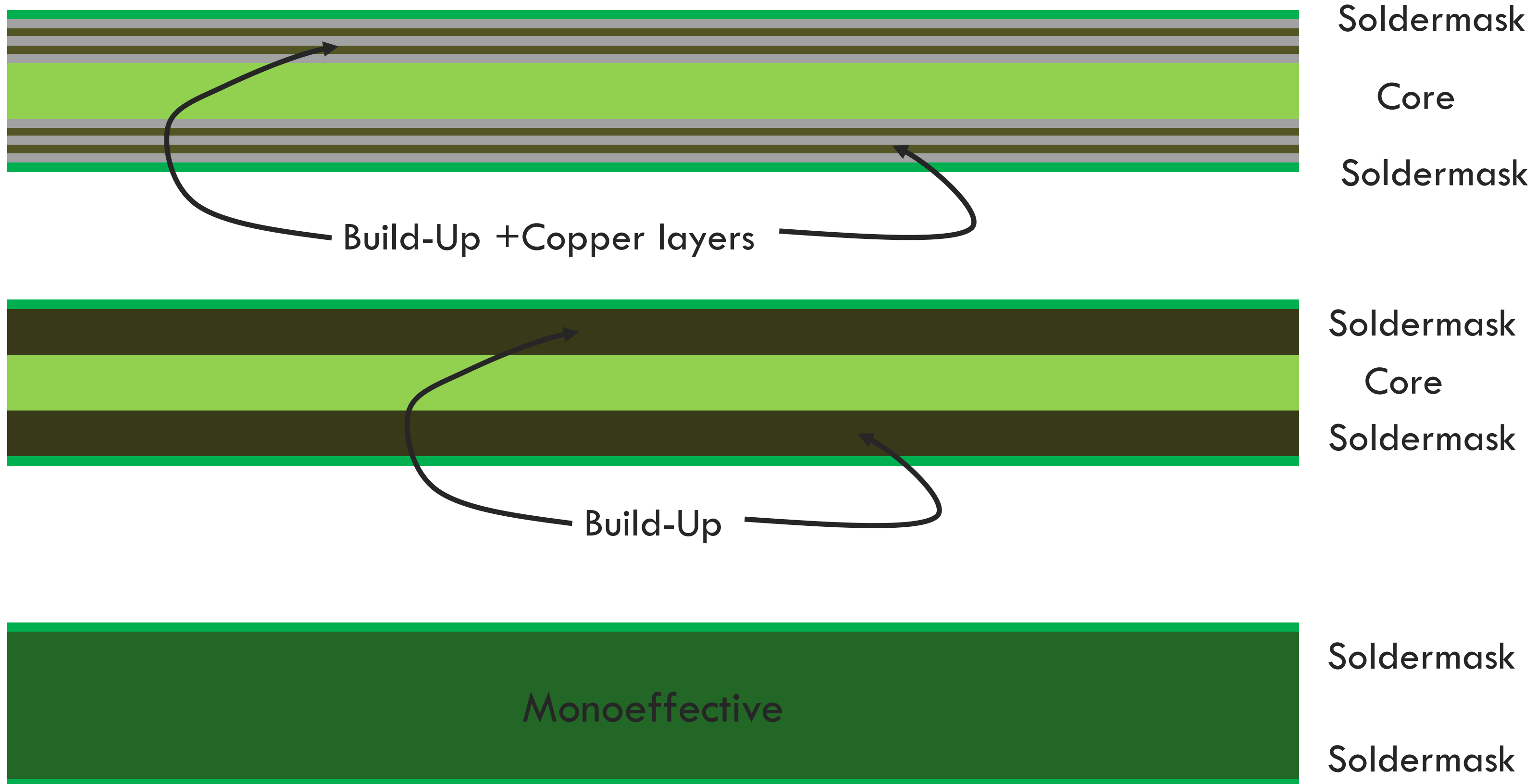
Options for Modeling the Stackup



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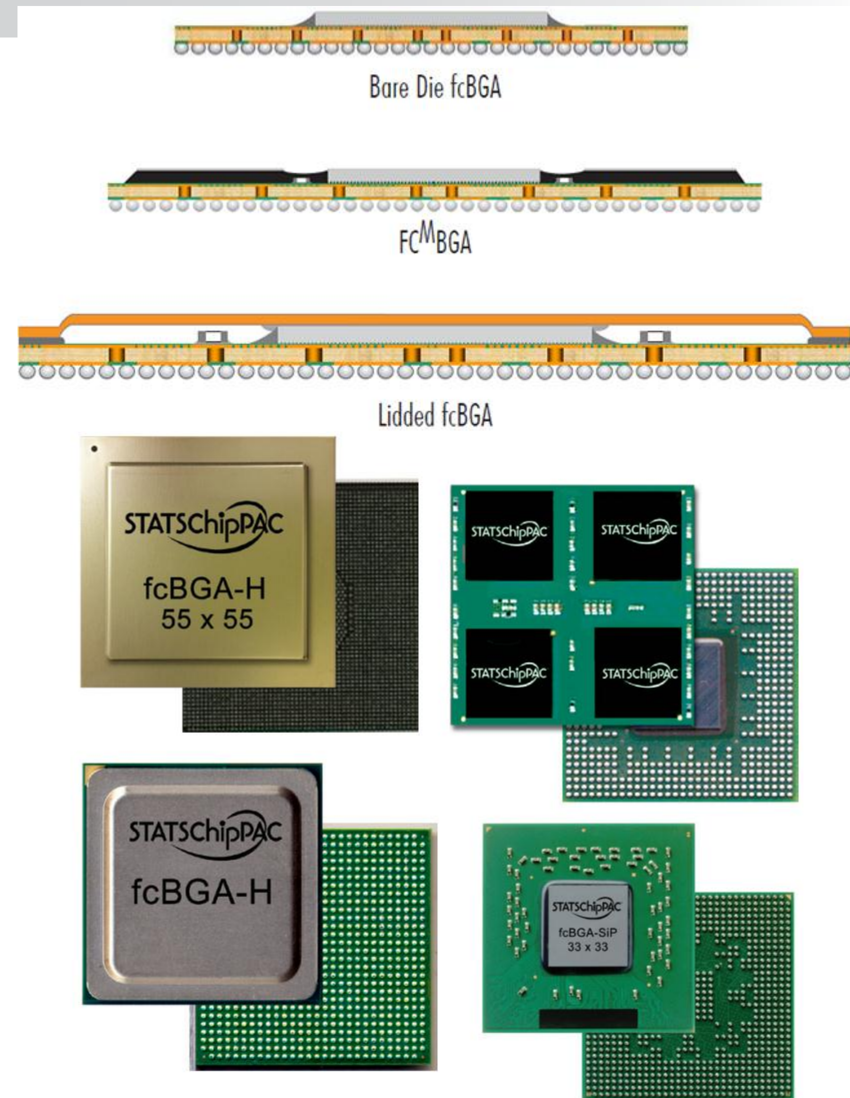
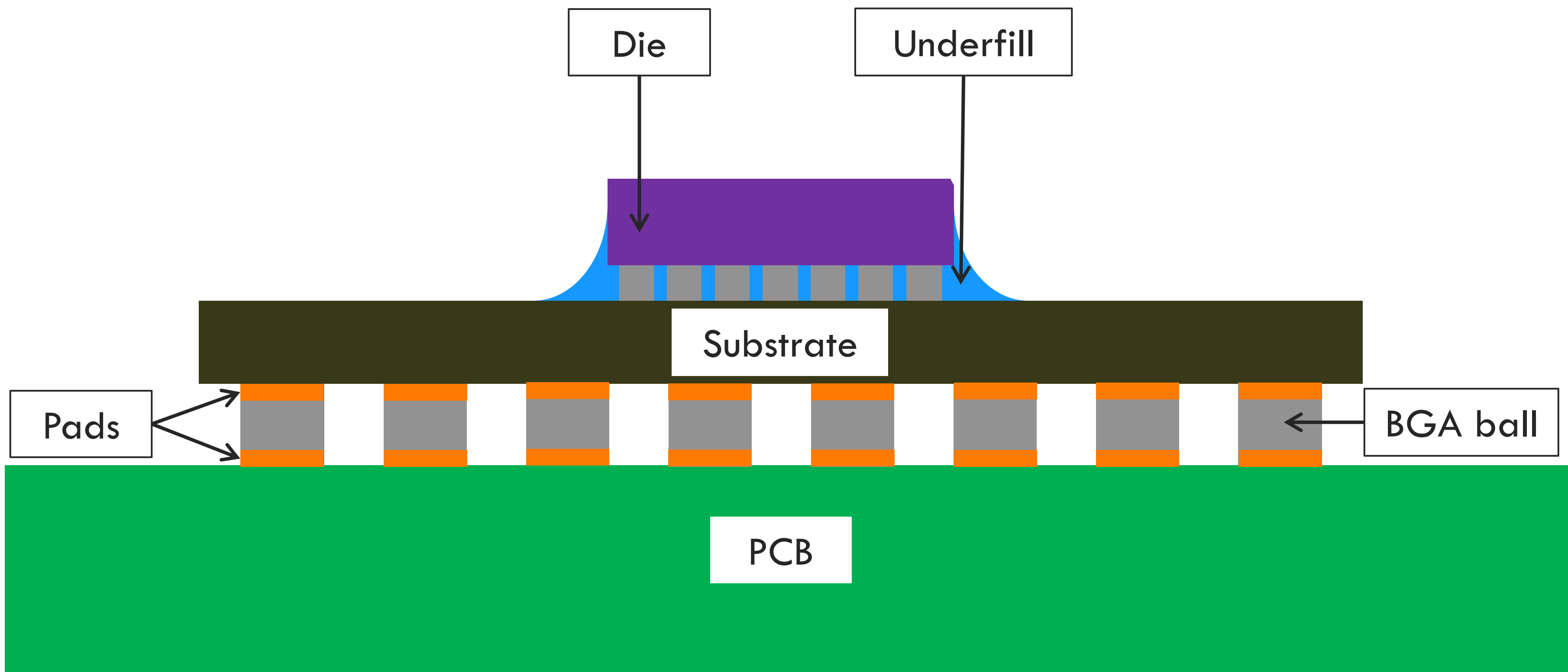
Flavors of Flip Chips

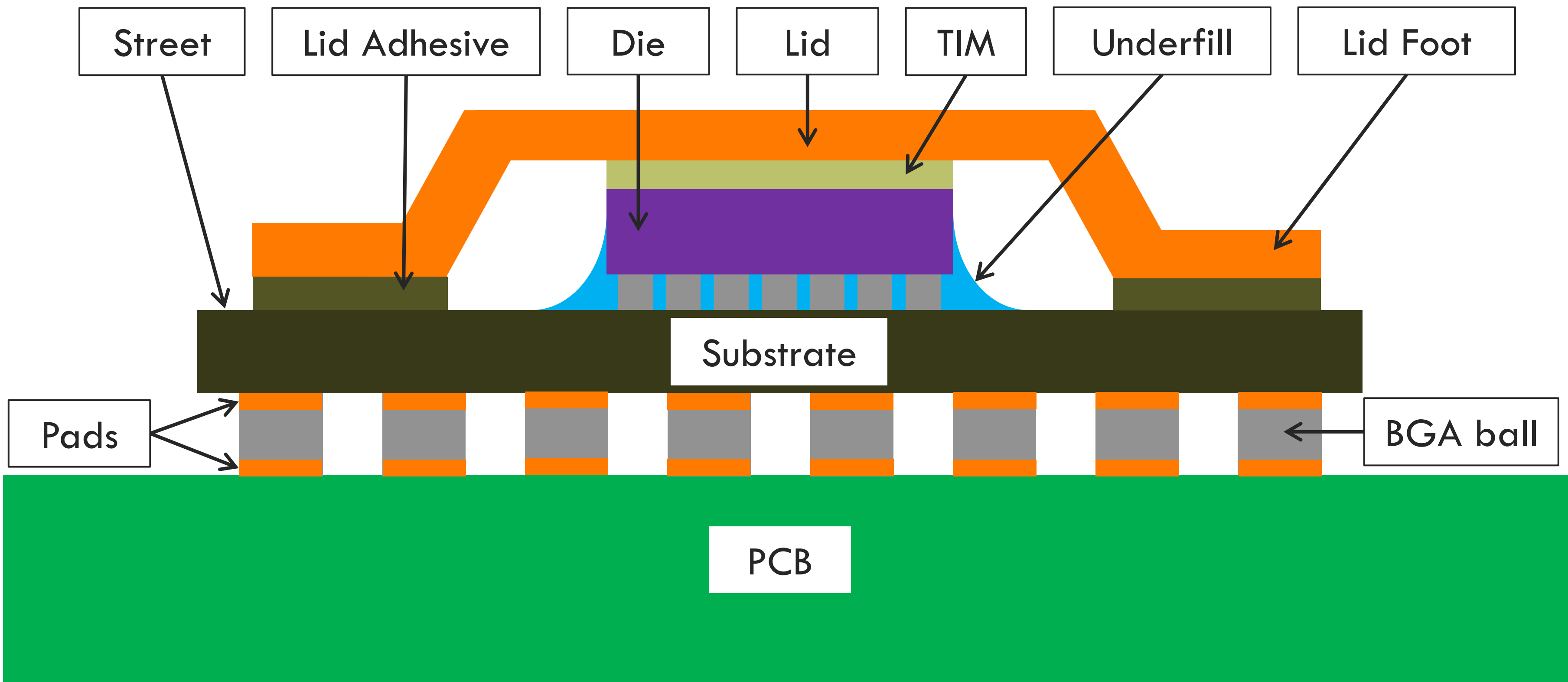
- Flip chip bare die
  - With or without underfill
  - Stiffener ring
- Lidded package
  - Single piece
  - 2 Piece
- Molded
  - With or without underfill
  - Exposed die or overmolded
- Flip chip: chip scale package
- Copper pillar or SnAg bump
- And many more
  - Chip on board
  - Glob top



Bare Die with Underfill



Lidded



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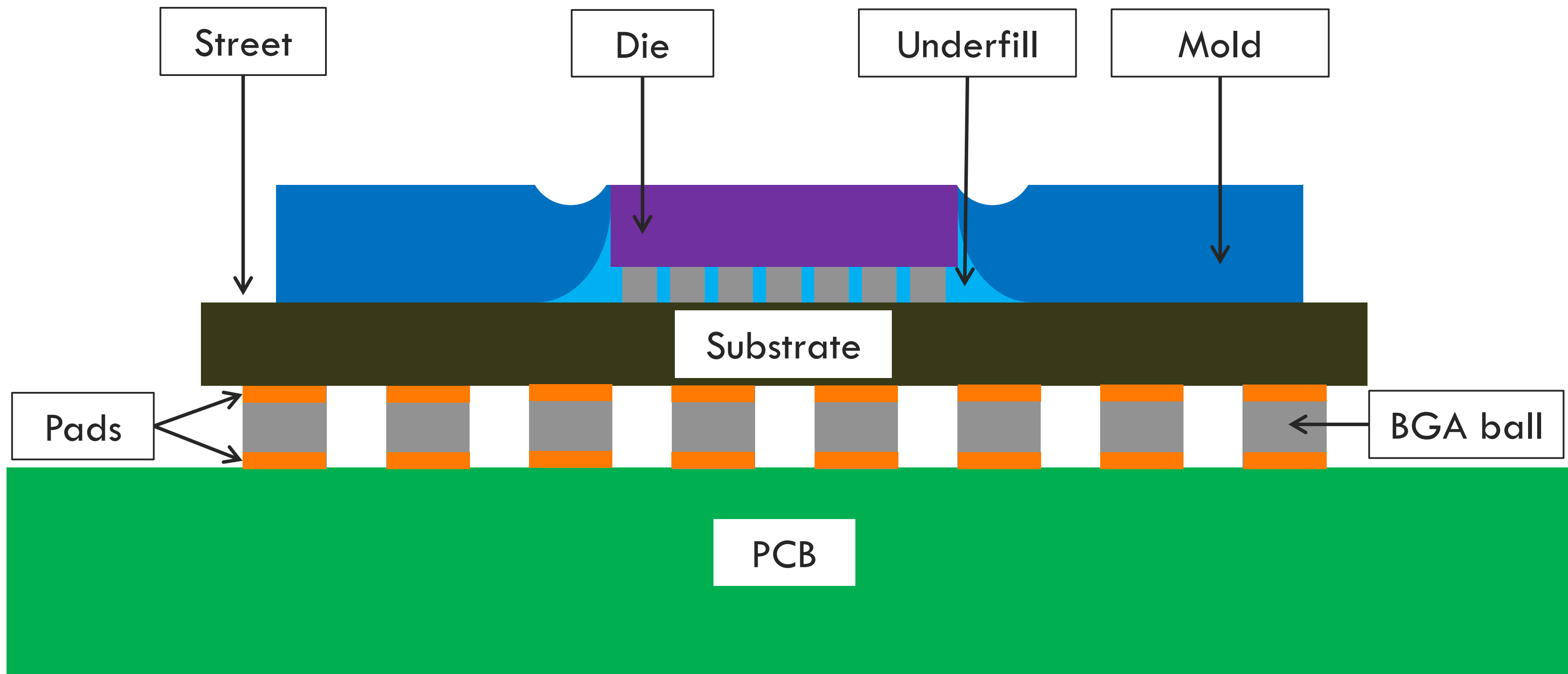
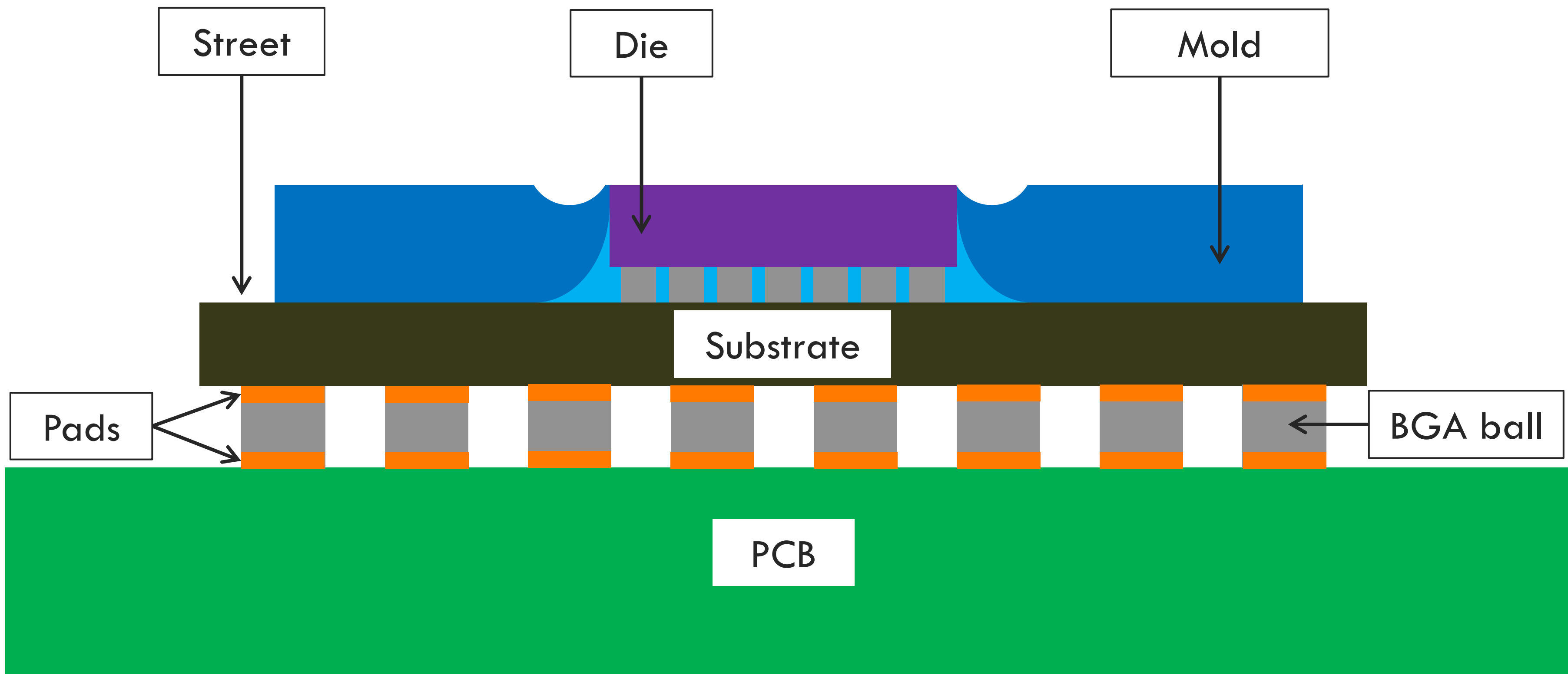
Exposed die: Molded + UF



Molded BGA: Exposed Die



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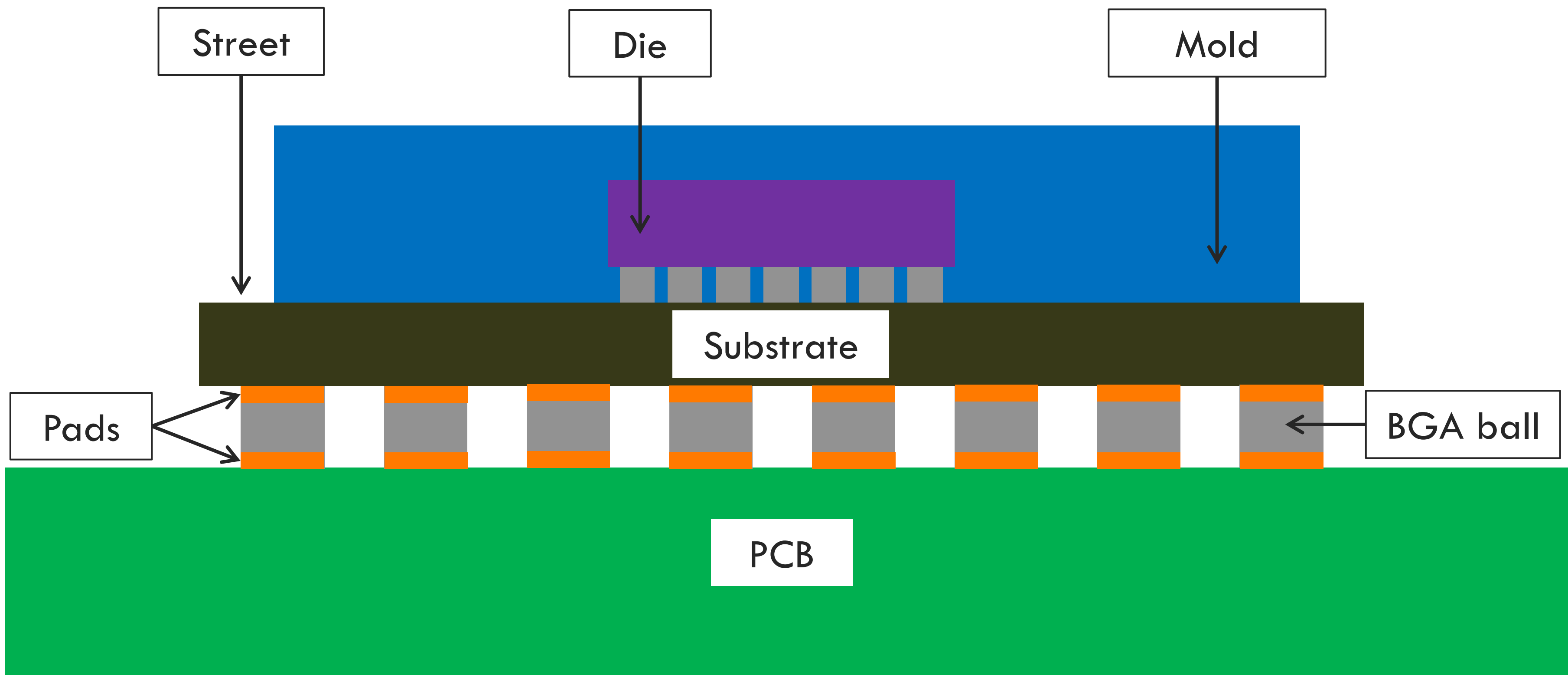
Overmold BGA



Issues in Flip Chip Packaging

- White bump
  - During Chip attach
  - Stresses in the ELK layer
- Solder ball reliability
  - Solder fatigue of BGA balls
  - Temp cycling
- Flip chip bump reliability
  - Solder fatigue of C4 SnAg bump
  - Temp cycling
- Warpage
  - Coplanarity of the package
  - Measured at (-55)°C and 260°C
- Die backside stress
  - During chip attach
  - Die cracking
- Bond line thickness
  - TIM thickness at various temps
  - Affects θ_{jc} (thermal resistance: Junction to case)

Remember This

- Flip chips don't want to survive
- Series of trade-offs between failure modes
- "Passed Qual" is a myth
- Know your environments
- Audit your suppliers
- Expect failure: Have a plan