

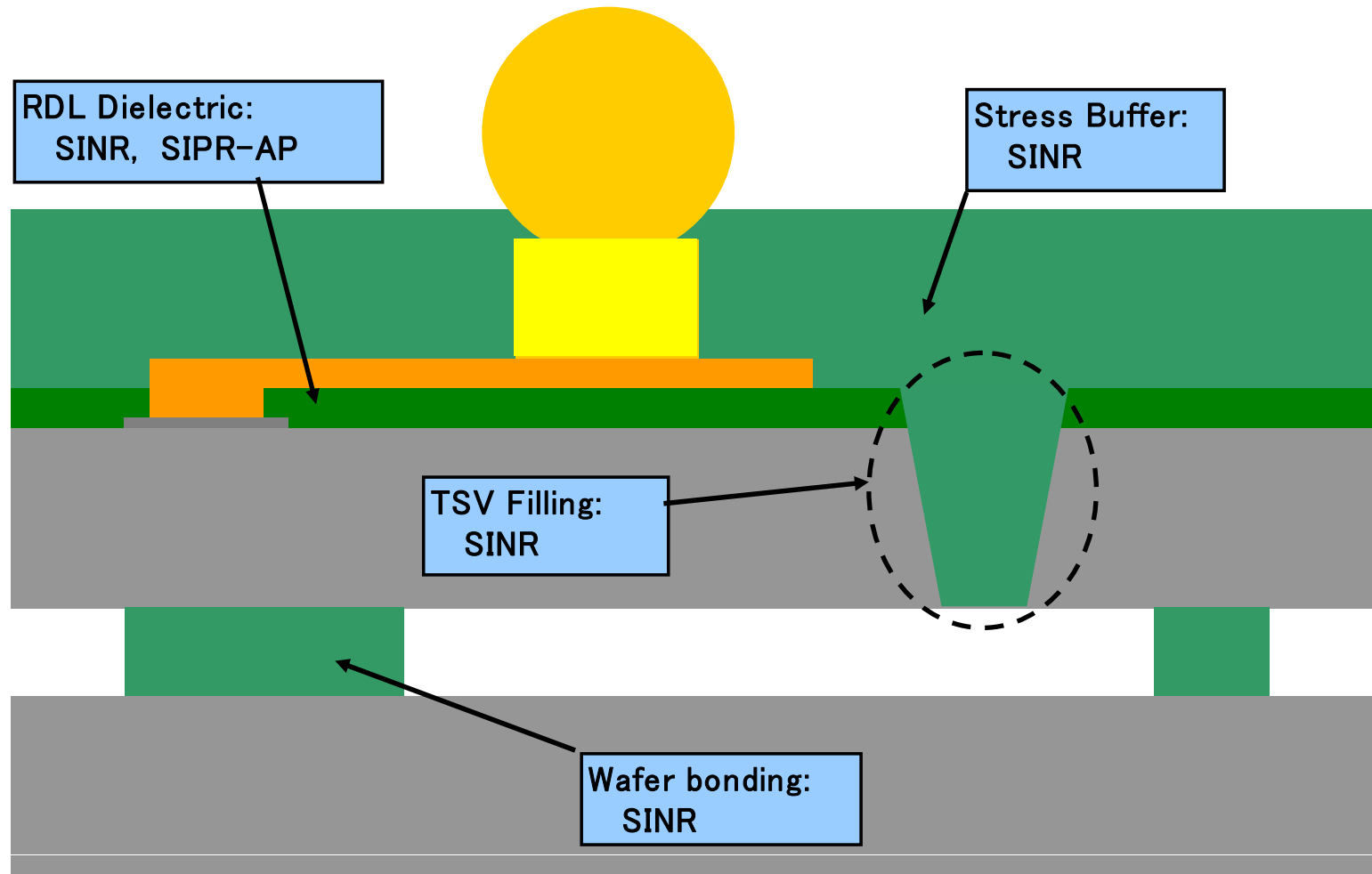
## Photodefinable Materials for Advanced Packaging

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- Spin-On Dielectrics
- Wafer Bonding Dielectrics
- Dry Film Dielectrics
- Electroplating Resists

# Spin-On Dielectrics

# Applications for Dielectric Materials

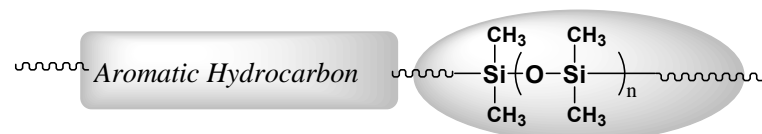


# SINR Photosensitive Silicone Dielectrics

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## SINR Materials Platform

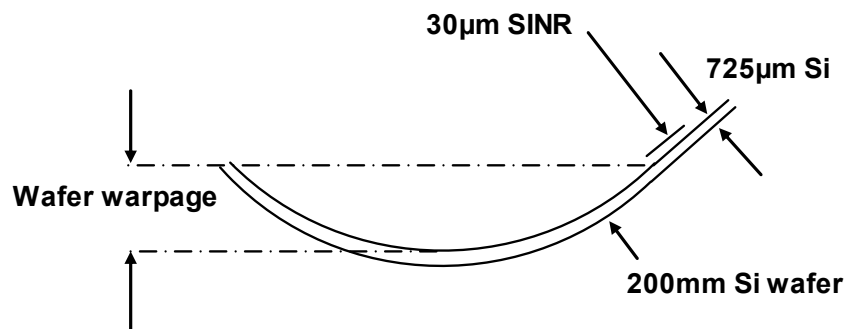
- Based on novel siloxane chemistry
- i-line or broadband sensitive
- Negative tone
- IPA or PGME developable
- Ultra-low modulus (as low as 90 MPa) for low residual stress
- Low-temperature & rapid cure (180°C/1 hr or 160°C/2 hr)
- Low shrinkage after cure (<10%)
- Low dielectric constant (2.6)
- Excellent adhesion to organic & inorganic materials
- Excellent shelf-life (6 months/0-15°C or 1 month at RT)
- Available in various forms:
  - Spin-on
  - Dry film



# SINR Mechanical Properties

Wafer warpage and stress controlled by siloxane content

Product	Siloxane Content (%)	Young's Modulus (GPa)	CTE (ppm/°C)	Wafer Warpage (μm)	Stress on Si (MPa)	Elongation (%)
SINR-3110	10	1.4	80	15.5	2.6	15
SINR-3150	50	0.24	130	12	2.0	40
SINR-3170	70	0.15	180	1.2	0.2	40



30μm of SINR on  
725μm-thick 200mm Si wafer

# SINR-3170PFM on Aluminum

	<i>Mask CD= 20 μm L&amp;S</i>	<i>30 μm L&amp;S</i>	<i>40 μm L&amp;S</i>
<b>Exp.</b> <b>(i-line)</b> = <b>1000</b> <b>mJ</b>			
<b>1200</b> <b>mJ</b>			

FT = 22μm

SB = 100°C / 120 sec

PEB = 110°C / 120 sec

# SINR-3170PFM on Aluminum

	<i>Mask CD= 20 μm Hole</i>	<i>30 μm Hole</i>	<i>40 μm Hole</i>
<b>Exp.</b> <b>(i-line)</b> = <b>1000</b> <b>mJ</b>			
<b>1200</b> <b>mJ</b>			

FT = 22μm

SB = 100°C / 120 sec

PEB = 110°C / 120 sec

# Wafer Bonding Dielectrics

## SINR-3570 Series Dielectrics for Wafer Bonding

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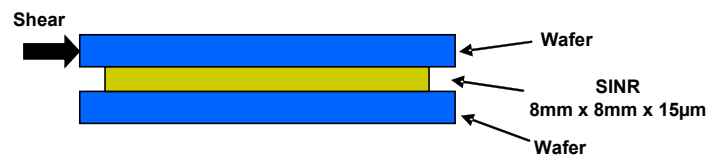
- Based on SINR-3170 chemistry
  - Modified for bonding at room temperature
- Good adhesion for bonding:
  - Chip-to-wafer
  - Wafer-to-wafer
  - Wafer-to-glass
- 70%-siloxane content for minimal wafer bowing
- Same 180°C/1 hour cure as for SINR-3170
- Minimal resist outgassing after wafer bonding

# Adhesion

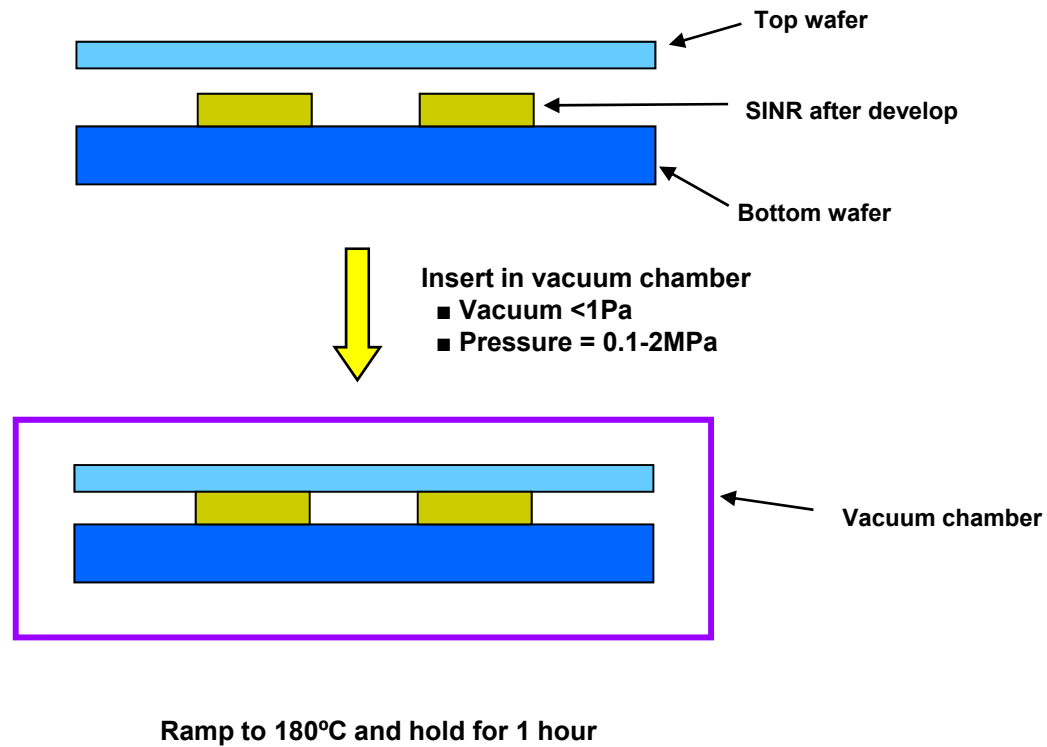
- SINR materials have excellent adhesion to most organic, inorganic materials, and itself
- Typical values for Si and SiON:

<i>Product</i>	<i>Substrate</i>	<i>Adhesion strength</i>	<i>Mode of failure</i>
SINR-3570PFM (Spin-on)	Si	11.2 MPa	SINR-wafer surface
SINR-DF3570PFM (Dry Film)	Si	11.7 MPa	SINR-wafer surface
SINR-3570PFM (Spin-on)	SiON	13.6 MPa	Wafer broke
SINR-DF3570PFM (Dry Film)	SiON	13.8 MPa	Wafer broke

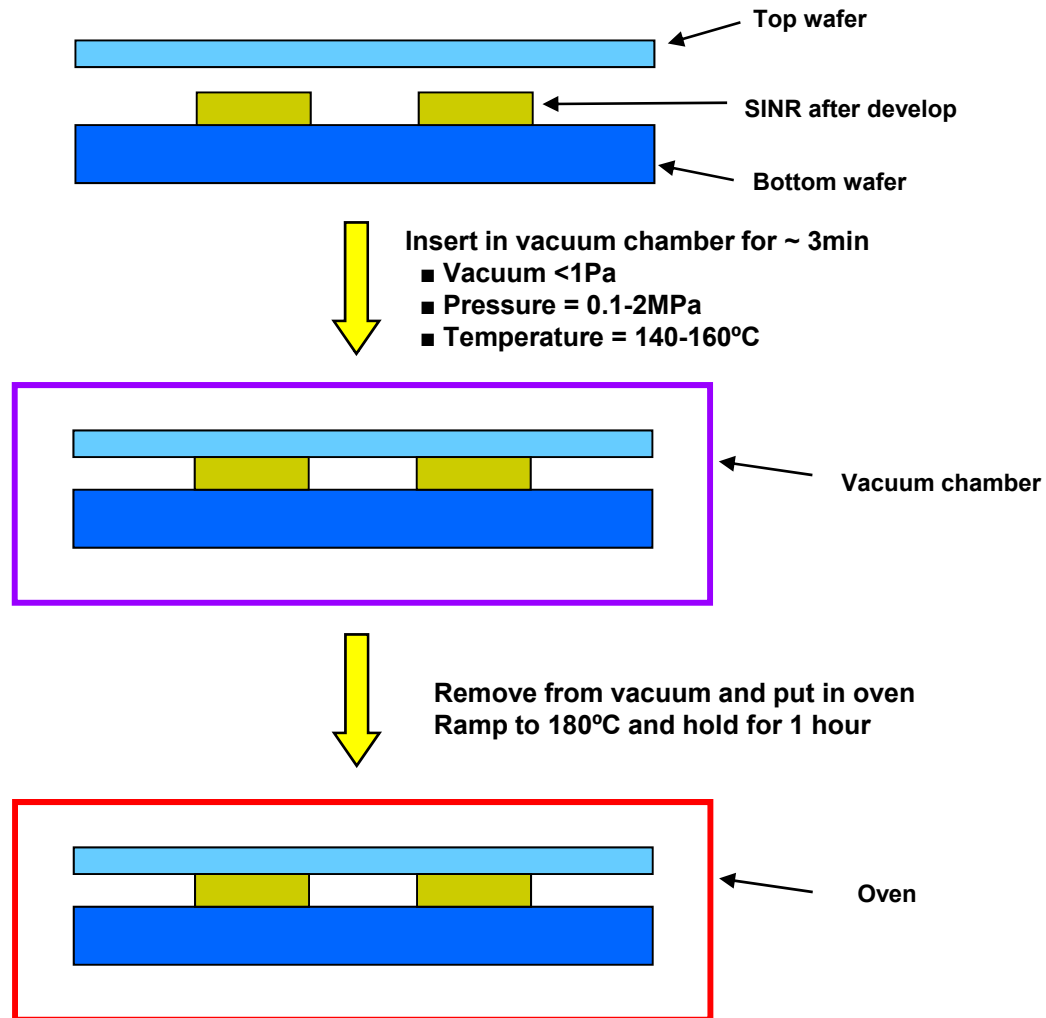
Die shear test method:



# Attach/Cure Process 1



# Attach/Cure Process 2



# Dry Film Dielectrics

# SINR Dry Film Dielectrics

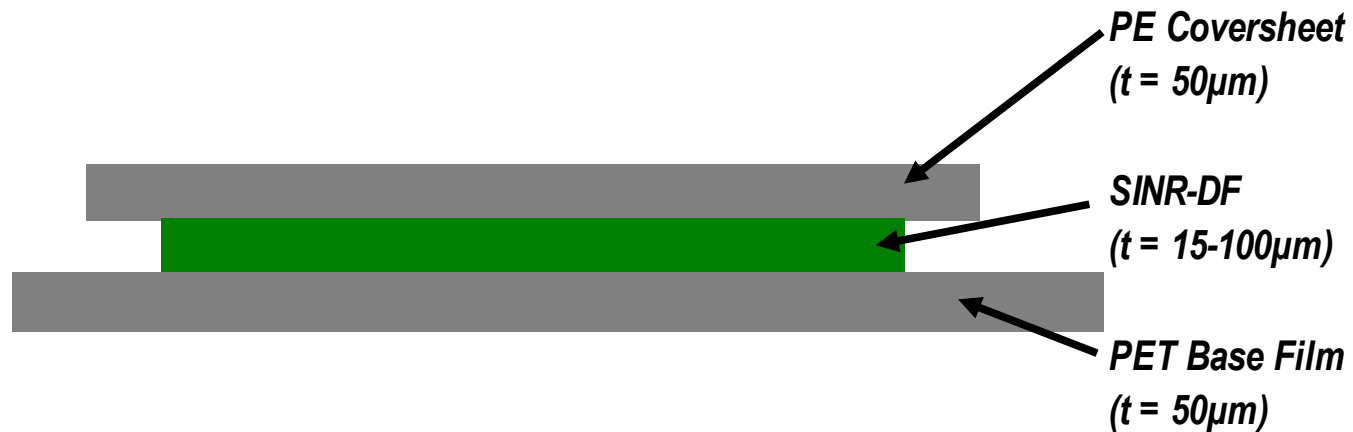
- Family of products
- Chemistry and physical properties similar to spin-on SINR products
- Current applications:
  - Wafer bonding
  - Backside stress buffer/RDL
  - TSV filling



# SINR Dry Film Dielectrics

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Construction for 200mm wafer and 300mm wafers:



Dry film thickness: 12-100μm

# Electroplating Resists

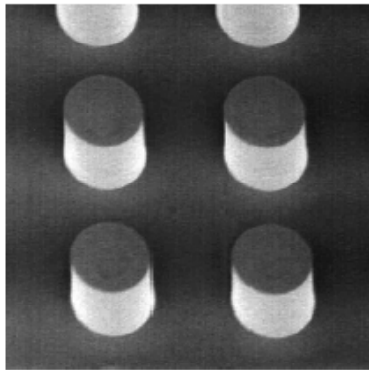
# SIPR-7120 Series Electroplating Photoresists

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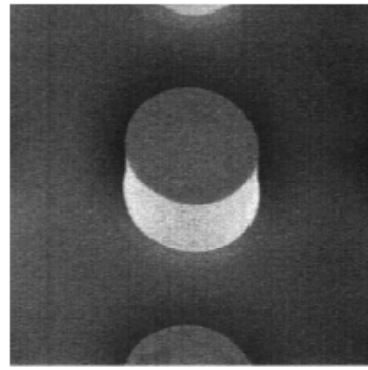
- Applications
  - Solder bump plating
  - Copper pillar plating
  - Gold bump plating
  - Copper redistribution plating
  - Etching
- Properties
  - i-line sensitive (broadband tool OK)
  - Positive tone
  - Chemically amplified for faster photospeeds
  - Capable of 10-100 $\mu$ m in a single coat
  - No PEB required
  - TMAH developable
  - Good plating resistance
  - Easily stripped in acetone or NMP

# Copper Pillars After Resist Strip

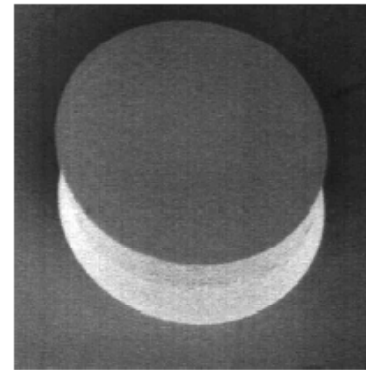
## Cu Pillar CD Linearity



(a) 30 μm pillar



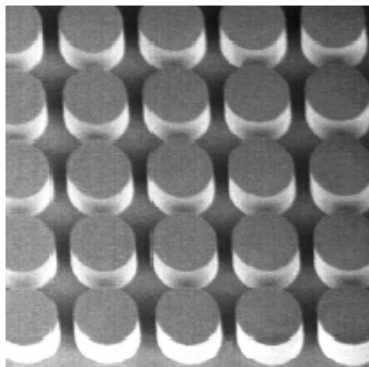
(b) 50 μm pillar



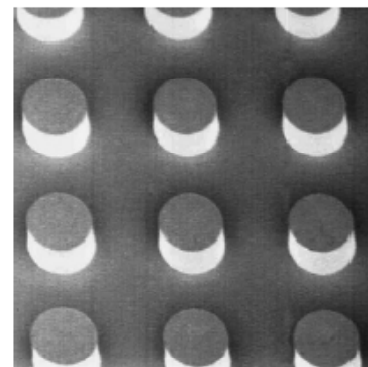
(c) 100 μm pillar

FT (SIPR-7123M) = 55μm  
Resist removal: Acetone, 10 min @ 21°C  
Cu pillar height ~ 30μm  
Cu seed wafers

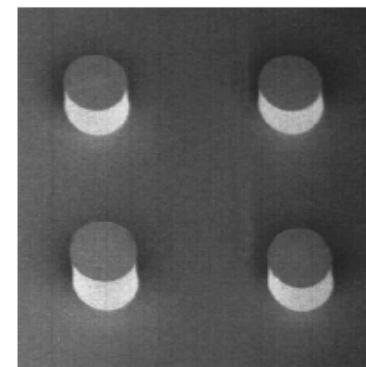
## Iso- and Dense 50μm Pillars



(a) 12.5 μm spacing



(b) 50 μm spacing

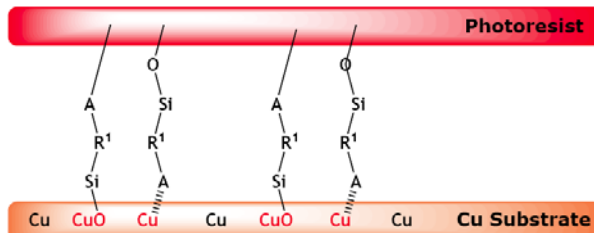


(c) 100 μm spacing

# Metal Adhesion Promoters

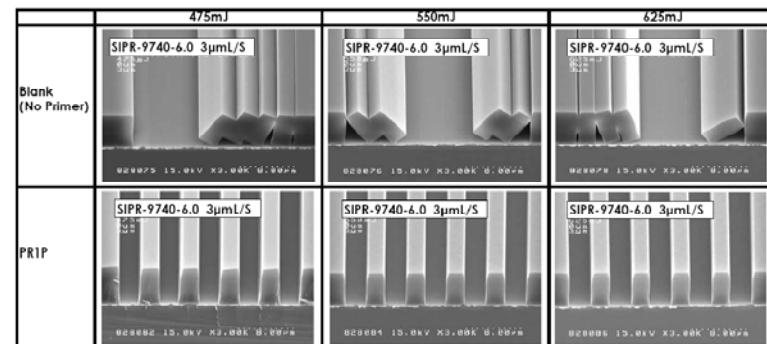
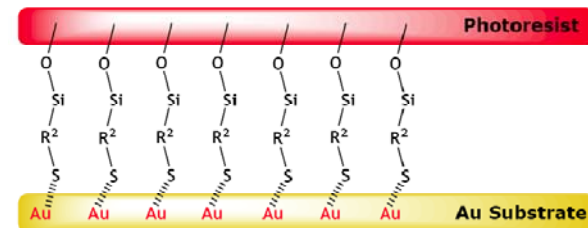
## PR1P

- Designed to enhance adhesion to copper
- Two functional groups to maximize adhesion to copper and copper oxide



## PR20P

- Designed to enhance adhesion to gold



SIPR-9740 on Copper  
With and Without PR1P