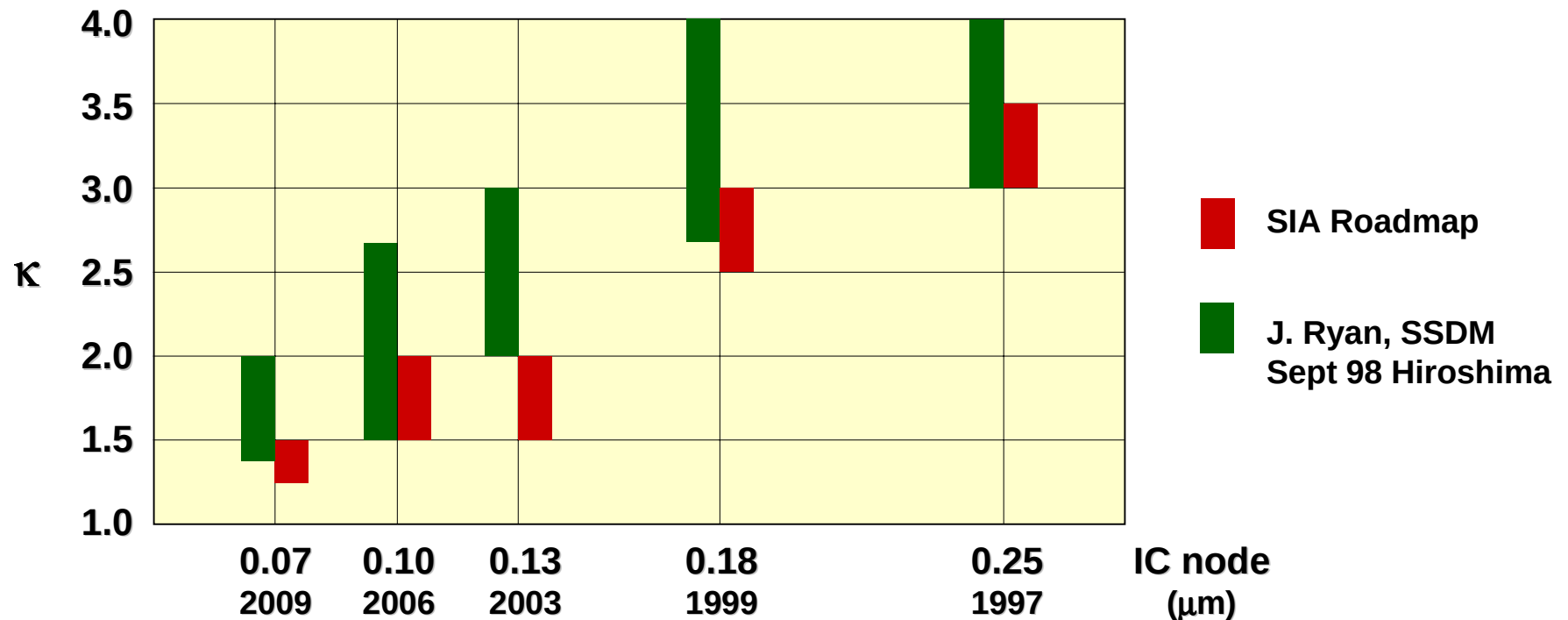


SIA Roadmap vs Reality

“For 0.18 μm ... logic processes, companies are using inorganic low- κ dielectrics, predominantly fluorinated oxide (FSG), but also, hydrogen silsesquioxane (HSQ).”

Semiconductor International Jan 1999.



Low κ Possibilities

Table 1. Likely Low-k Materials for ULSI Interconnects

Dielectric	Dielectric constant (k)	Glass transition temperature (T _g)(°C)	Refractive index	Water absorption (%)	Stress (MPa)	Gap fill (μm)	Cure temperature (°C)	Weight loss (%wt) at 450°C
FSG (silicon oxyfluoride, Si _x OF _y)	3.4-4.1	>800	1.42	<1.5	-130	<0.35	no issue	none
HSQ (hydrogen silsesquioxane)	2.9	>500	1.37	<0.5	70-80	<0.10	350-450	<3
Nanoporous silica	1.3-2.5	>500	1.15	TBD	0	<0.25	400	none
Fluorinated polyimide	2.6-2.9	>400	ΔRI >0.15(ai)	1.5	2	<0.5	350	<0.1
Poly(arylene) ether	2.6-2.8	260-450	1.67	<0.4	60	<0.15	375-425	<1.0
Parylene AF4 (aliphatic tetrafluorinated poly-p-xylylene)	2.5	T _{melt} >510	1.548 ΔRI >0.09(ai)		100	0.18	420-450	0.5
PTFE (polytetrafluoroethylene)	1.9	-100	1.34	<0.01	25-27	<0.30	360-390	0.8
DVS-BCB (divinyl siloxane bis-benzocyclobutene)	2.65	>350	1.561	<0.2	30-35	<0.22	300	<1.0
Aromatic hydrocarbon	2.65	>490	1.628	<0.25	55-60	<0.05	400-450	<1.0
Hybrid-silsesquioxanes	<3.0	T _{melt} >250	1.58	0	30-40	<0.1	450	6

Organic ■ Inorganic ■

Remaining Low κ Candidates

Inorganic vs. Organic **F vs. no F** **Porous vs. Non-porous** **CVD vs. Spin-on**
Hybrids

Material	Technique	Trade Name	Company
F_xSiO_y	CVD		
HSQ	Spin-on	Flowable Oxide	Dow Corning Allied Signal
Nanoporous Si	Spin-on	Nanoglass	Allied Signal
F-polyimide	Spin-on		
Poly(arylene) ether	Spin-on	FLARE VELOX	Allied Signal Schumacher
Parylene	CVD		Novellus Watkins Johnson
Aromatic hydrocarbon	Spin-on	SiLK	Dow
PTFE	Spin-on	Speedfilm	Gore
DVS-BCB	Spin-on		Dow
Hybrid SQ's	Spin-on	MSQ	Dow Corning
Amorphous FC, HFC	PECVD		IBM, NEC Novellus, HP
	CVD	Black Diamond	Applied Materials