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FILTER FOR MILLIMETER-WAVE MULTI-CHIP MODULES ON LOW TEMPERATURE COFIRED CERAMIC

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Outline of the talk

- Introduction, general considerations
- Principle structure and design of the filter
- Theoretical results, tolerances
- Experimental results
- Conclusion

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LTCC

- Glas matrix ceramic, firing temperature ca. 850° C
- Dielectric constant adjustable in a wide range via type of ceramic (3.8 ... 80 or more for special applications)
- Low losses ($\tan\delta$ = 0.001 ... 0.004)
- Due to low temperature, good conductor materials can be used (Ag, Au)
- Limited thermal conductivity
- Structural dimensions ≥ 0.1 mm

HTCC

- Normal ceramics (Al_2O_3, AlN, ...)
- Good thermal conductor
- Firing temperature > 1600°
- Only special metals (W, Mo, ...)
- Low conductivity, no bonding/soldering without electroplating

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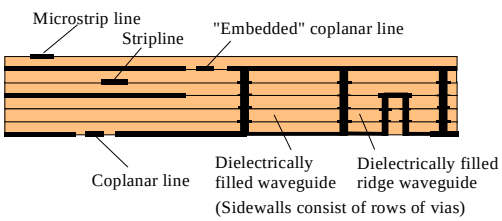

Cross section of a multi-layer substrate with different types of transmission lines.

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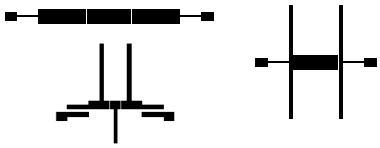
Application of LTCC is extended to the mm-wave range

Problem: design of band pass filters in the 28 - 30 GHz range



Design tools: HP ADS, FDTD (in house code)

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Typical standard (low cost) LTCC process:

Screen printing process

Lateral dimensions	± 100 µm
(line width/length/spacing, via position/size...)	
Shrinkage during burn-in	12% ± 0.3% (lateral)
Dielectric constant	5 ... 8 ± 0.15
Layer thickness	± 7%

There are better processes, but at (much) higher cost !!!

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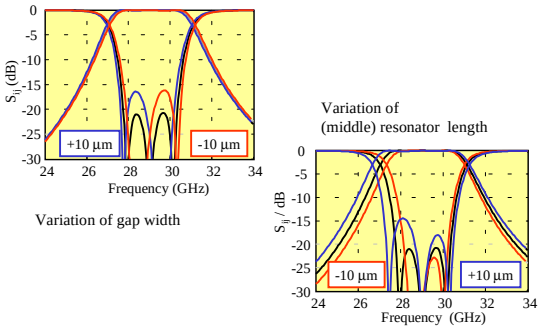

Tolerance problems with filter on LTCC (end coupled filter)

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Tolerances in the order of 10 µm or better are required for mm-wave filter design

Standard LTCC processes are not suited for such filters

(There are more accurate processes or even an additional thin film process after burn-in of the LTCC, but at much higher cost)

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Novel design of a drop-on filter

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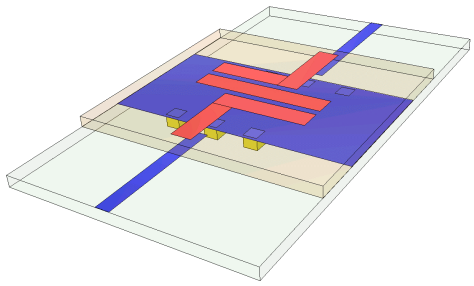

General structure of drop-on filter

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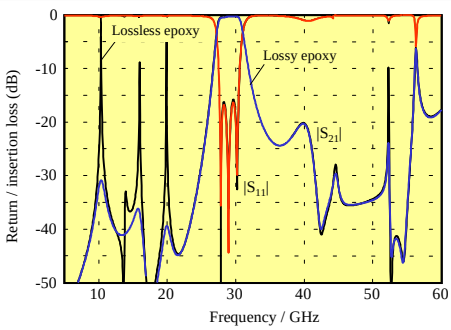

Ceramic chip filter with standard ground plane dimension

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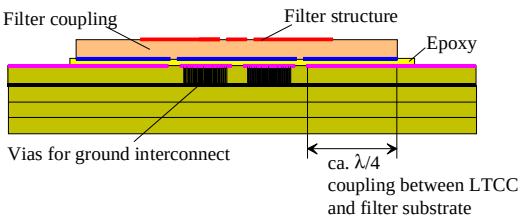

Cross section of drop-on filter structure

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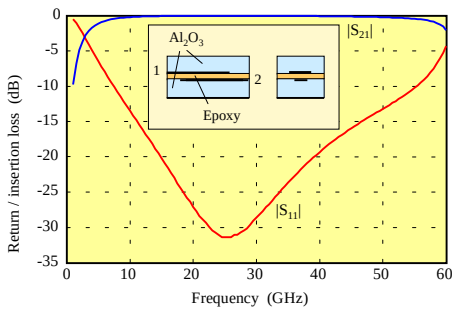

Coupling performance of thin film coupled strips

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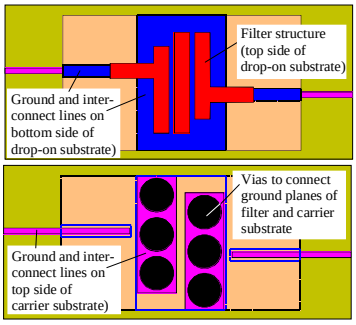

Basic metallization structure of drop-on filter

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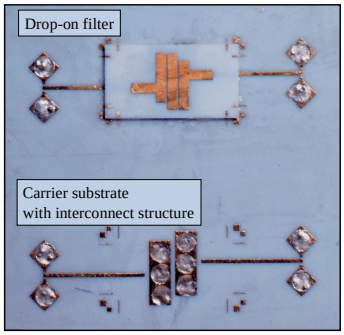

Drop-on filter with carrier structure on alumina

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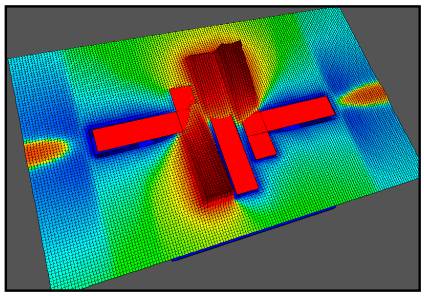

Field distribution of drop-on filter

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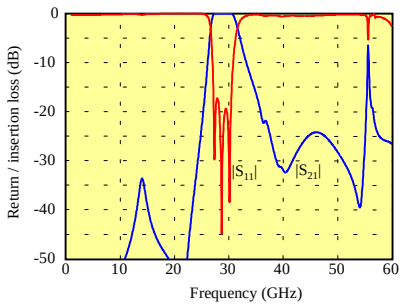

Theoretical wide band results of drop-on filter

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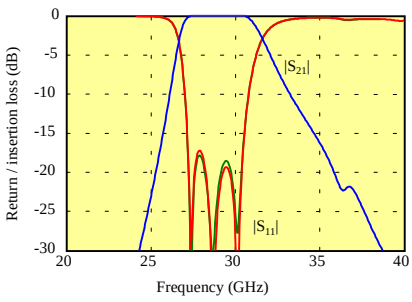
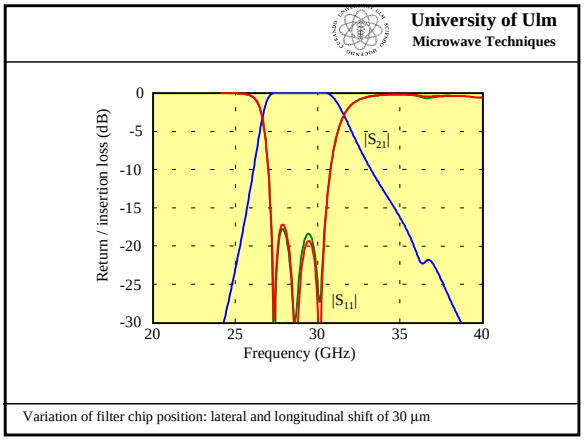
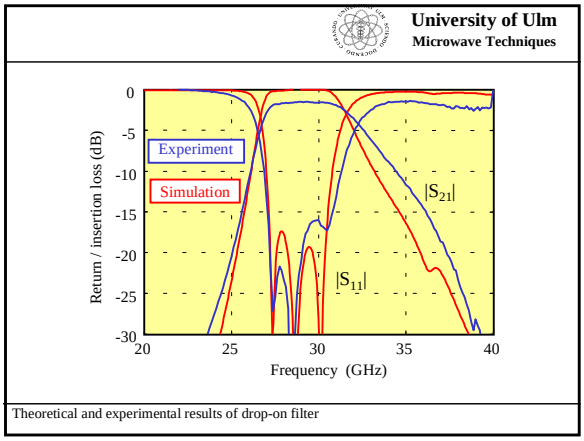


Variation of filter chip position: lateral shift of 30 µm



Variation of filter chip position: lateral and longitudinal shift of 30 µm



Theoretical and experimental results of drop-on filter