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Studies on a Fabric Feed Line Sewn to a Flexible Slot Antenna

Kazuhiro Fujiwara[1,] Hitoshi Shimasaki[2], Kazunari Morimoto[1]
[1] Department of Advanced Fibro-Science,
Kyoto Institute of Technology,
Matugasaki, Sakyo-ku, Kyoto, 606-8585 Japan,
[2] Department of Electronics,
Kyoto Institute of Technology,
Matugasaki, Sakyo-ku, Kyoto, 606-8585 Japan,
E-mail: simasaki@kit.ac.jp

Abstract: A cavity-backed slot antenna (CBSA) made of conductive textiles was fabricated with a polyester fabric feed line and evaluated in bending tests. The substrate of the feed line was also a textile sheet rather than conventional material in order to make the antenna more flexible. The feed line was sewn directly to the CBSA to eliminate the gap between the feed line and the antenna. The reflection and radiation characteristics in the 2.4-GHz band were measured for two types of fixing methods: sewn and fixed with adhesive tape. And then, the characteristics of both antennas were compared when they were bent. The -10dB bandwidth for the sewn antenna was wider than for the taped antenna. Thus, the antenna characteristics can be improved by reducing unnecessary deformation of the feed line and the antenna.

Keywords: Conductive textile; microwave; cavity-backed slot antenna; feed line; polyester fabric; flexibility

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Biography:

Kazuhiro FUJIWARA received the B.E. degree in 2014, M.E. degree in 2016, both from Kyoto Institute of Technology, Japan. His research topics were wearable antennas made of conductive textiles.

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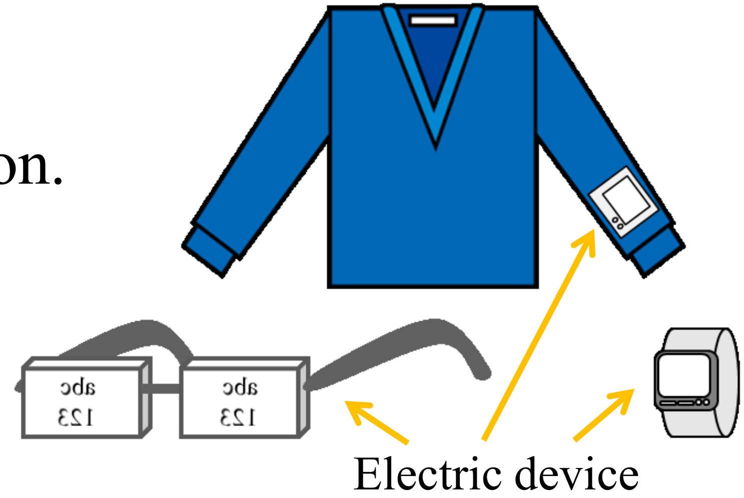
Kyoto Institute of Technology,
Matugasaki, Sakyo-ku, Kyoto, 606-8585 Japan,

[2]Department of Electronics,
Kyoto Institute of Technology,
Matugasaki, Sakyo-ku, Kyoto, 606-8585 Japan,
E-mail: simasaki@kit.ac.jp

Back ground

Wearable electronic devices used near or on the human body have attracted attention. They will be key components in our daily lives.



But…

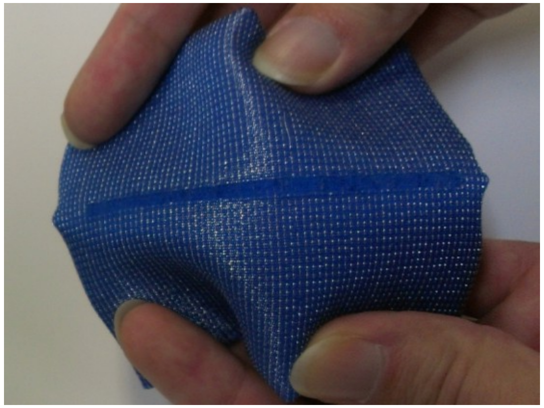
Problems (in wireless)

- Wearing metal antenna → On human body or curved item
- Antenna miniaturization with downsized transceiver → Performance degradation

required to be soft, thin, light and to maintain the size of antenna

Propose a Cavity-Backed Slot Antenna using conductive textiles

- Conductive textile
  → **A flexible antenna**
- Cavity backside
  → **Suppressing a backward radiation**
- Feeding by a microstrip line
  → **Non-contact feeding**
- A post-wall waveguide structure
  → **Reduction of the deformation**



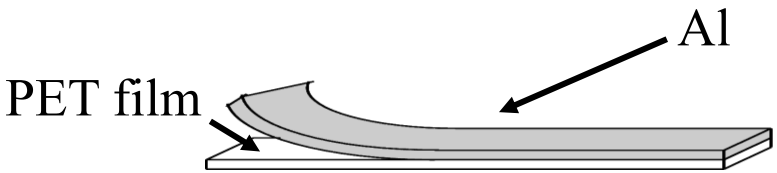
Textile slot antenna

↓ ***New approaches***

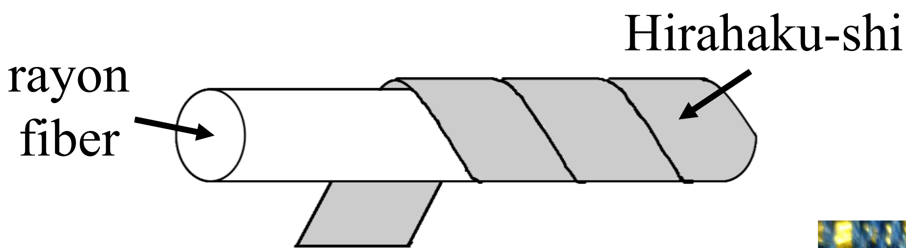
- Selected a fabric substrate for the feed line to bend more naturally.
- Sewed the fabric feed line to the CBSA by stitching polyester threads, instead of the previous fixation method by using adhesive tape.

Conductive threads and textiles

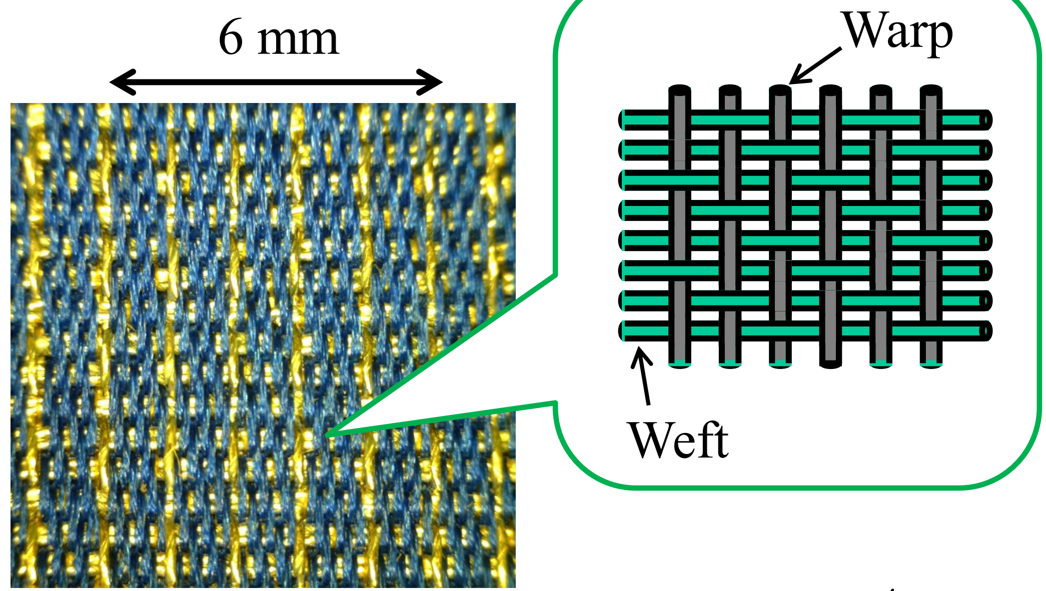
We used conductive textiles, which consist of Nen-shi. Then, the weft and warp were 3.7 and 0.78 threads/mm.



(a) Plain foil thread
(Hirahaku-shi)

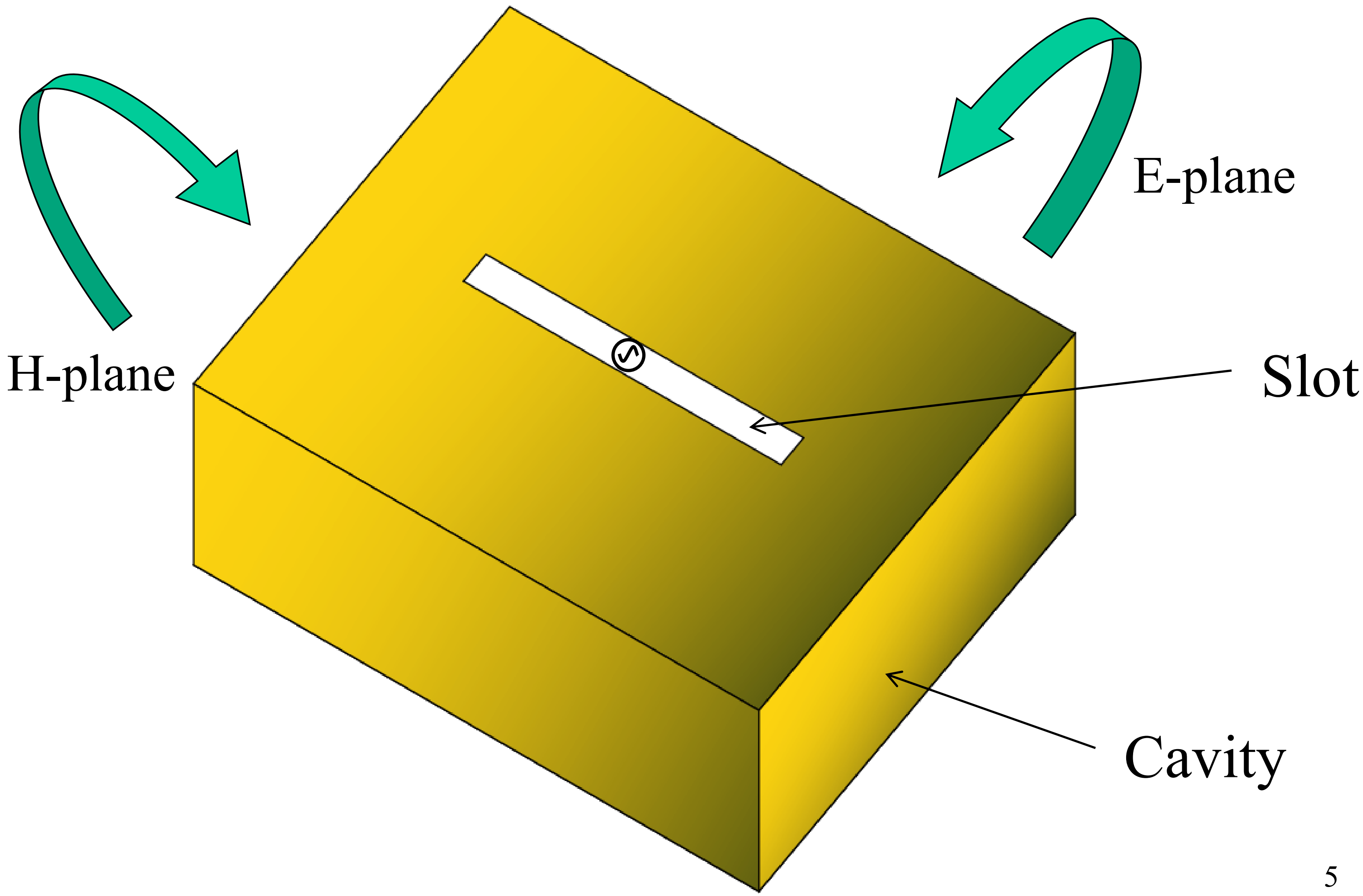


(b) Twisted thread
(Nen-shi)

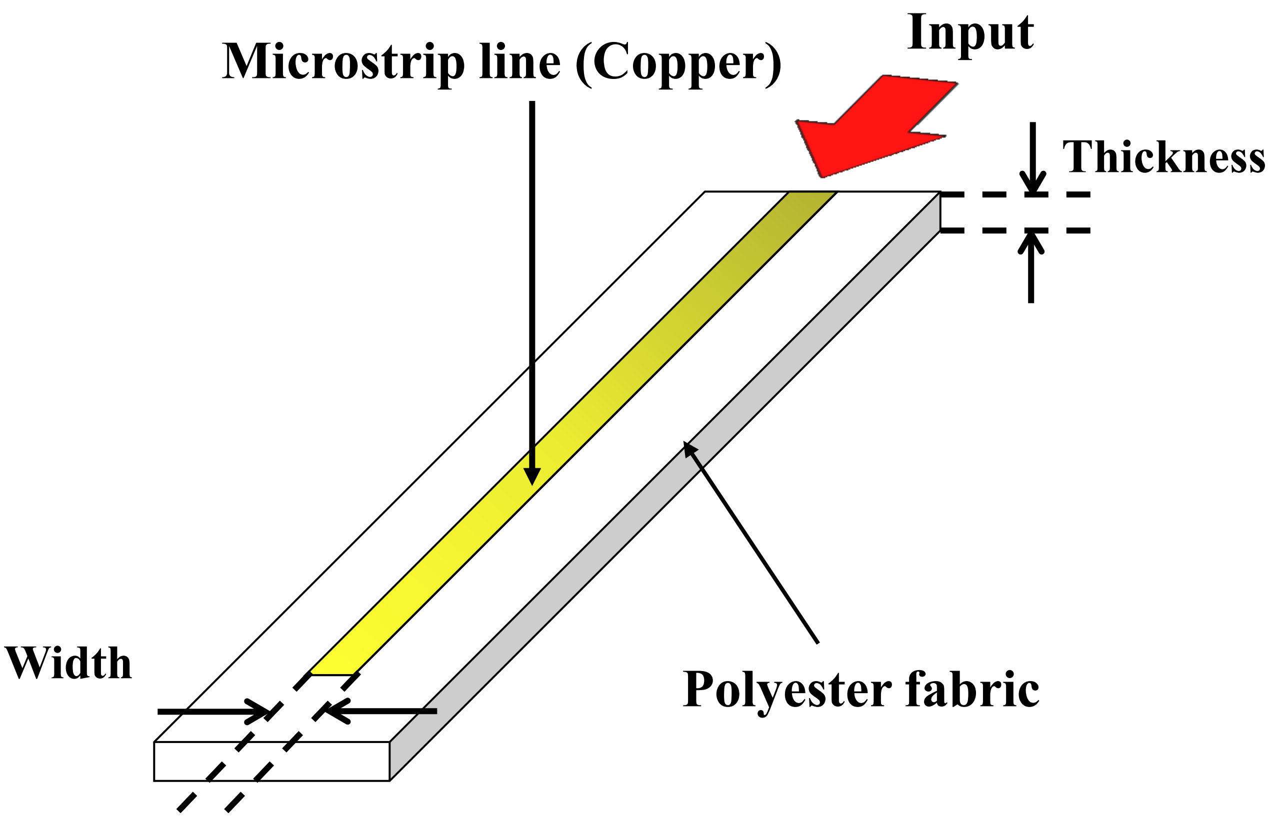


(c) Conductive textile

Cavity-Backed Slot Antenna: CBSA

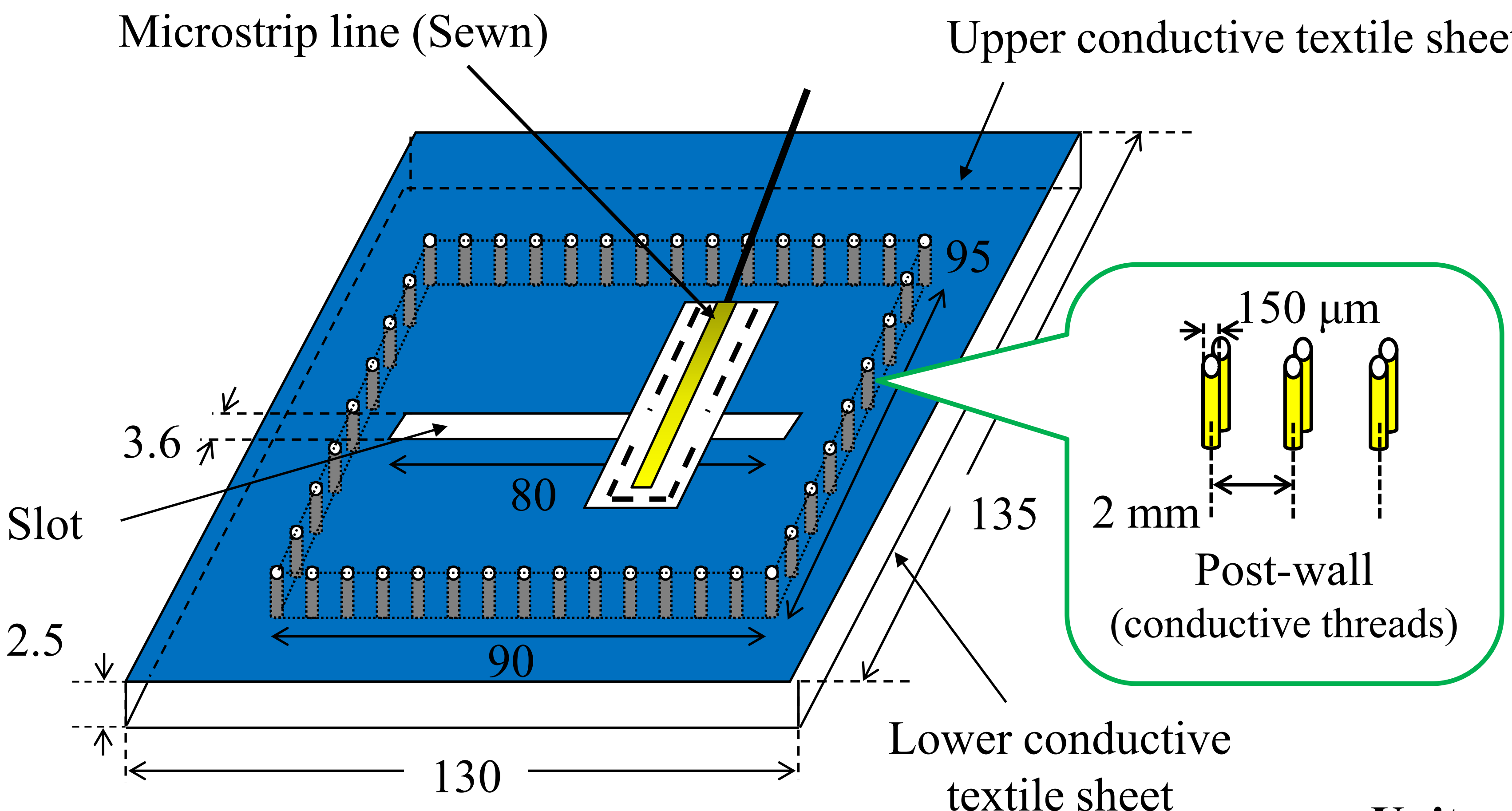


Feed line using a polyester fabric



	Strip width [mm]	Substrate thickness [mm]	Relative permittivity
Polyester fabric	2.6	0.72	1.36~1.38 (bulk : 2.8)
PTFE film	1.6	0.5	2.4

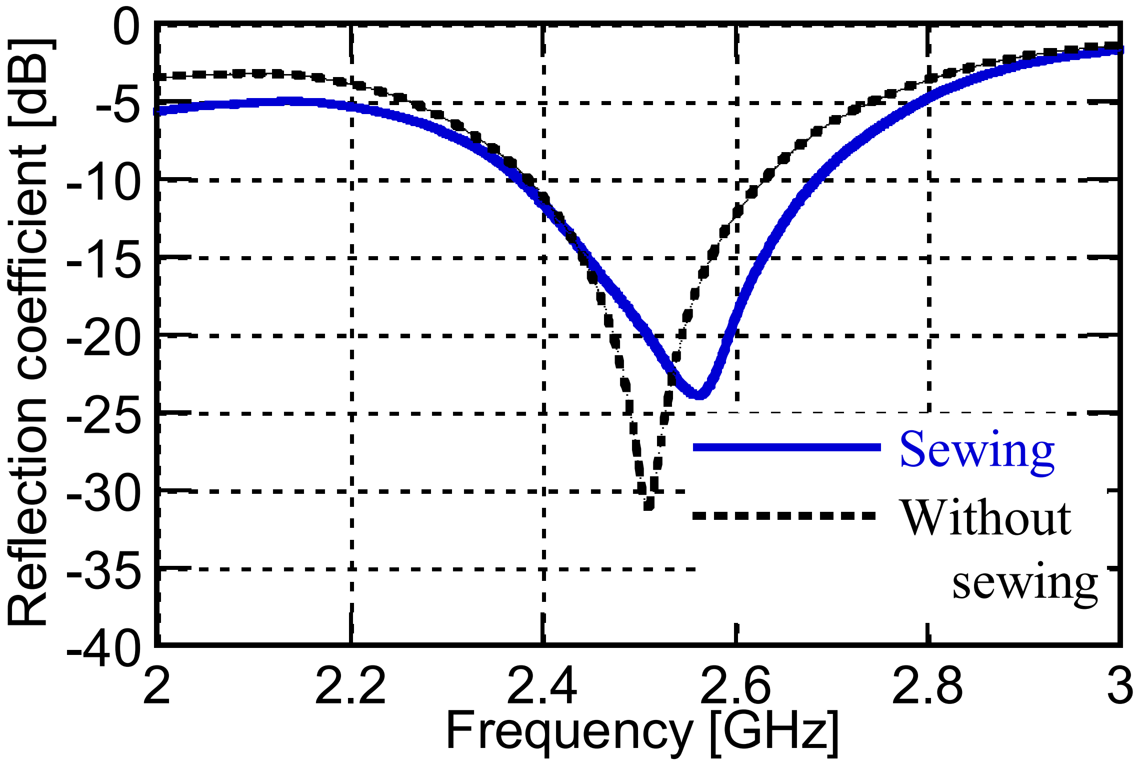
CBSA with the fabric feed line



Unit : mm

The offset position and the stub length are 20.0 and 27.2 mm. And we measured the reflection coefficient and the radiation patterns by a network analyzer.

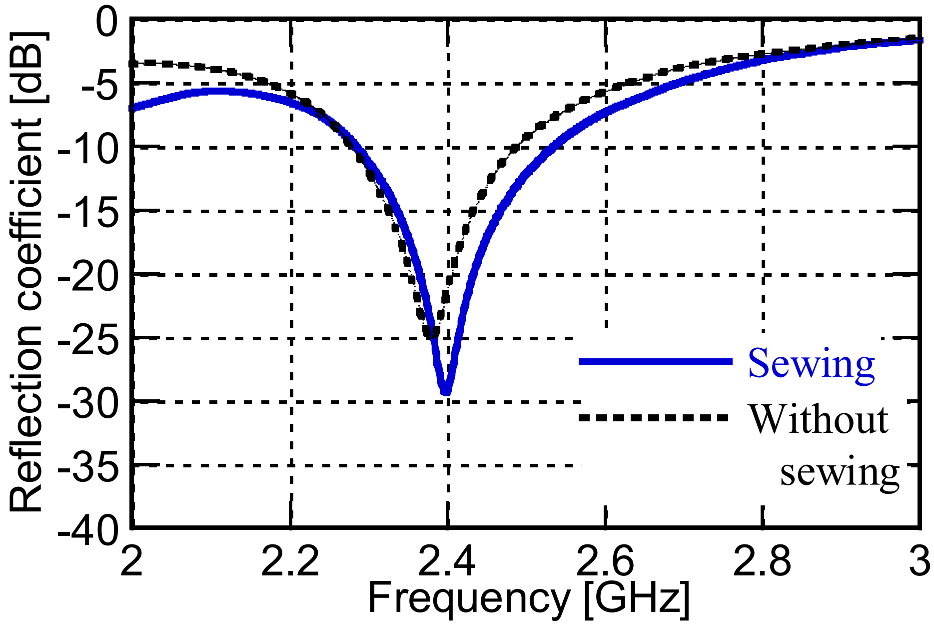
Reflection coefficient (Flat case)



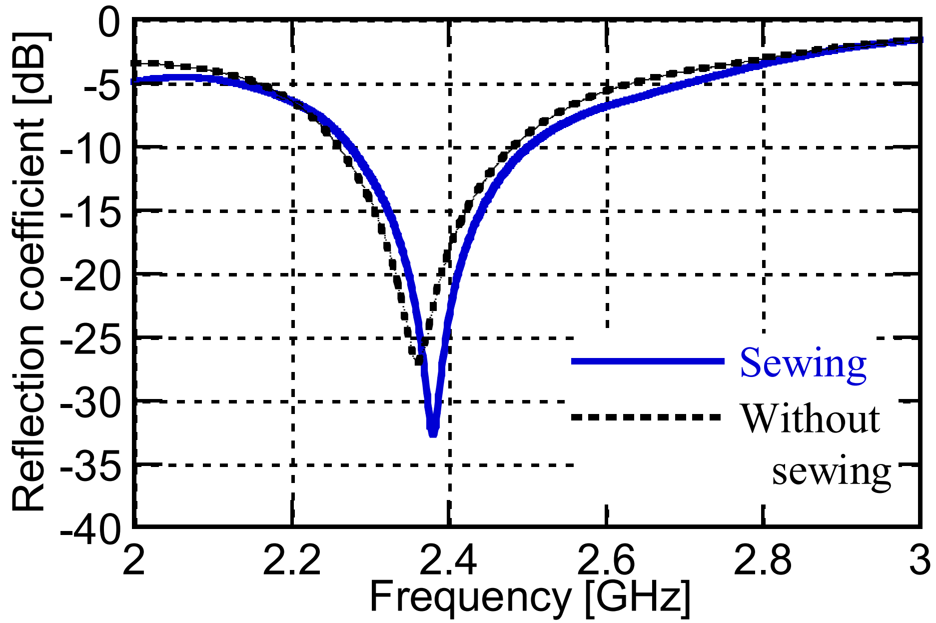
	Band width [MHz]	Center frequency [GHz]
Sewing	309	2.5305
Without sewing	245	2.5075

Reflection coefficient (Bending cases)

※Flat case (Sewing):
Band width：309 MHz， Center frequency：2.5305 GHz



r_c=225 mm

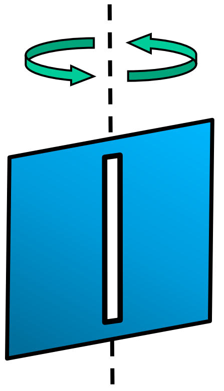


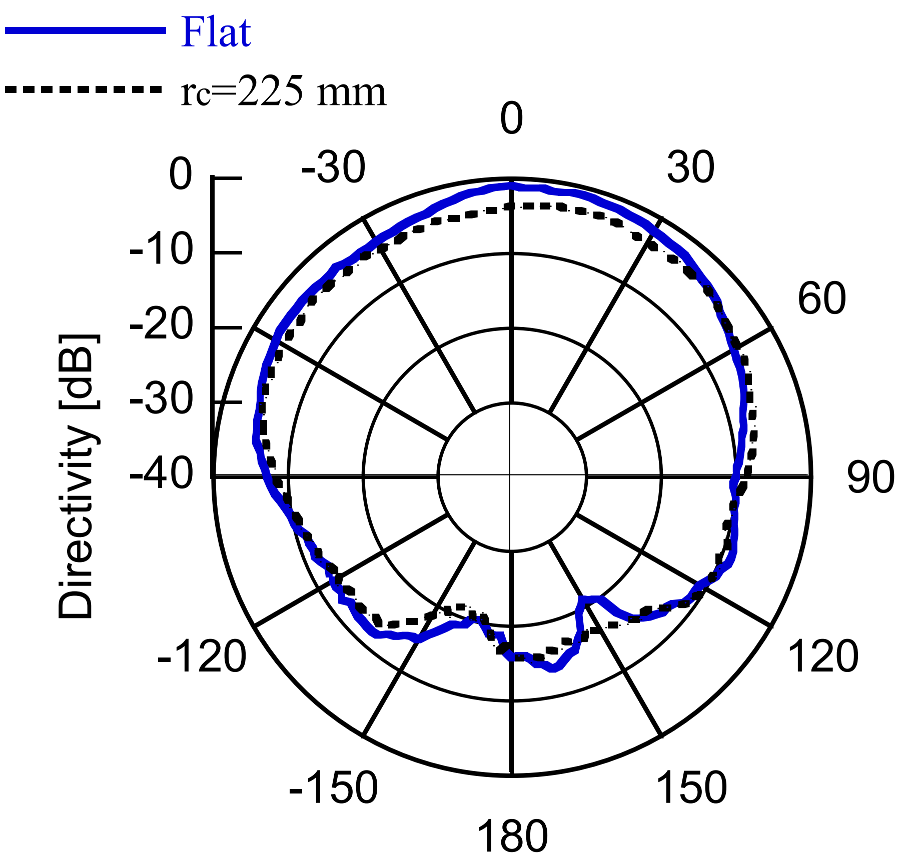
r_c=150 mm

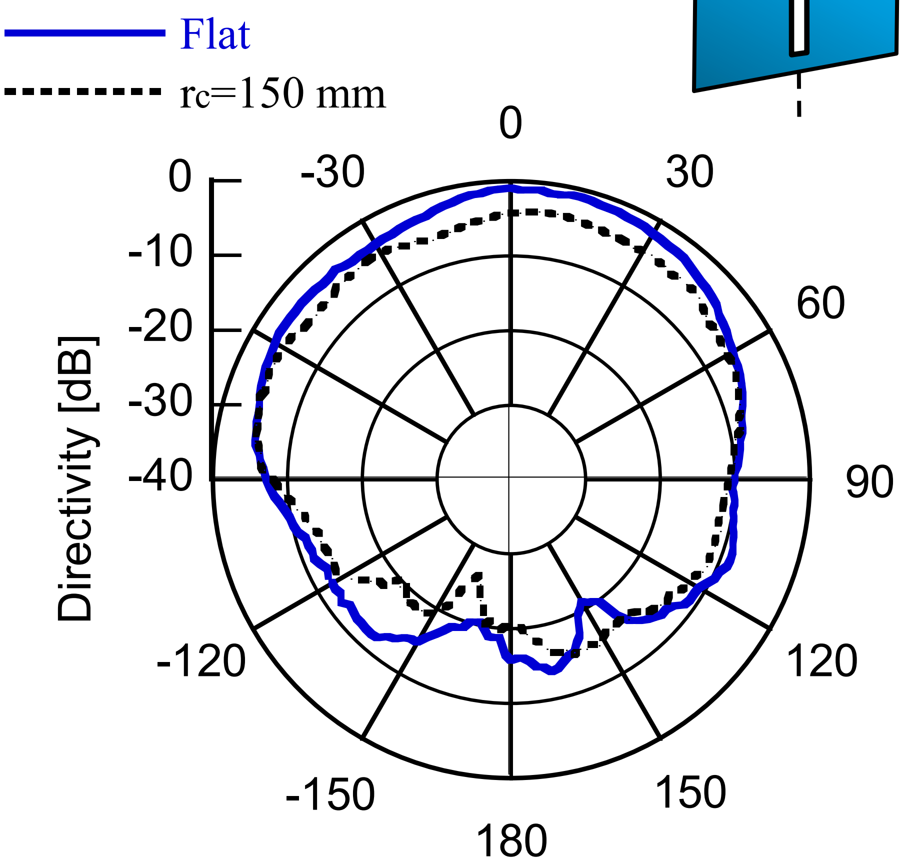
In the sewing cases, the band widths were wider and the center frequency were less shifted.

Radiation pattern (E-plane)

※Gain：1.94 dBi， Operation frequency：2.450 GHz

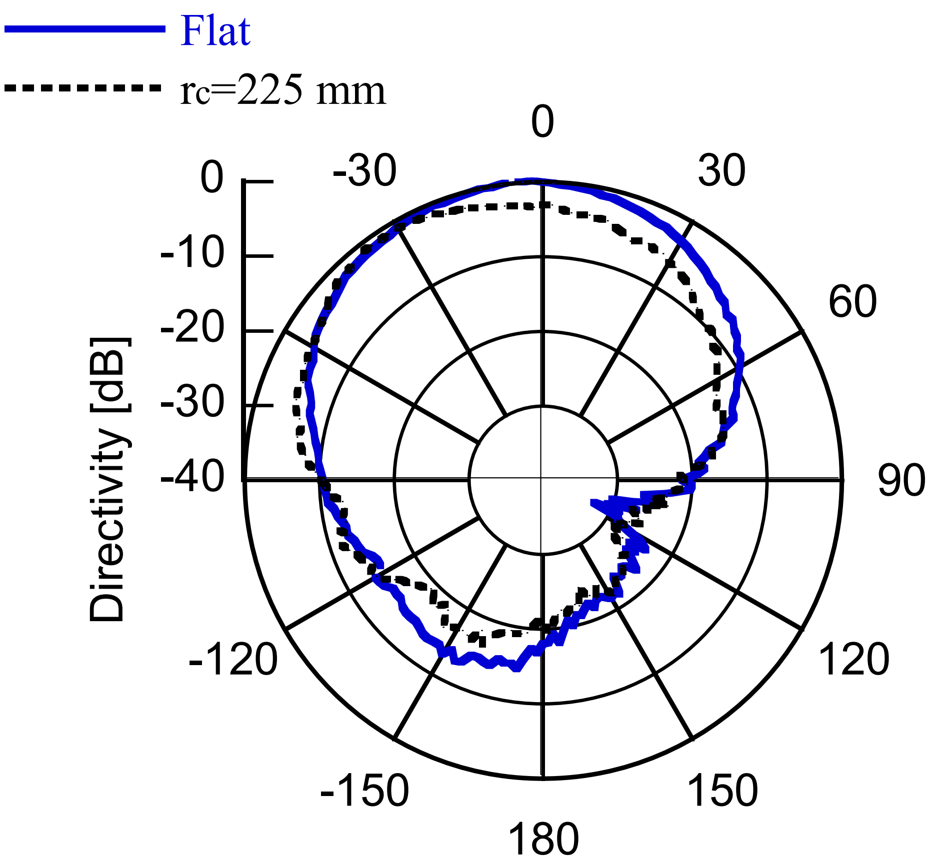


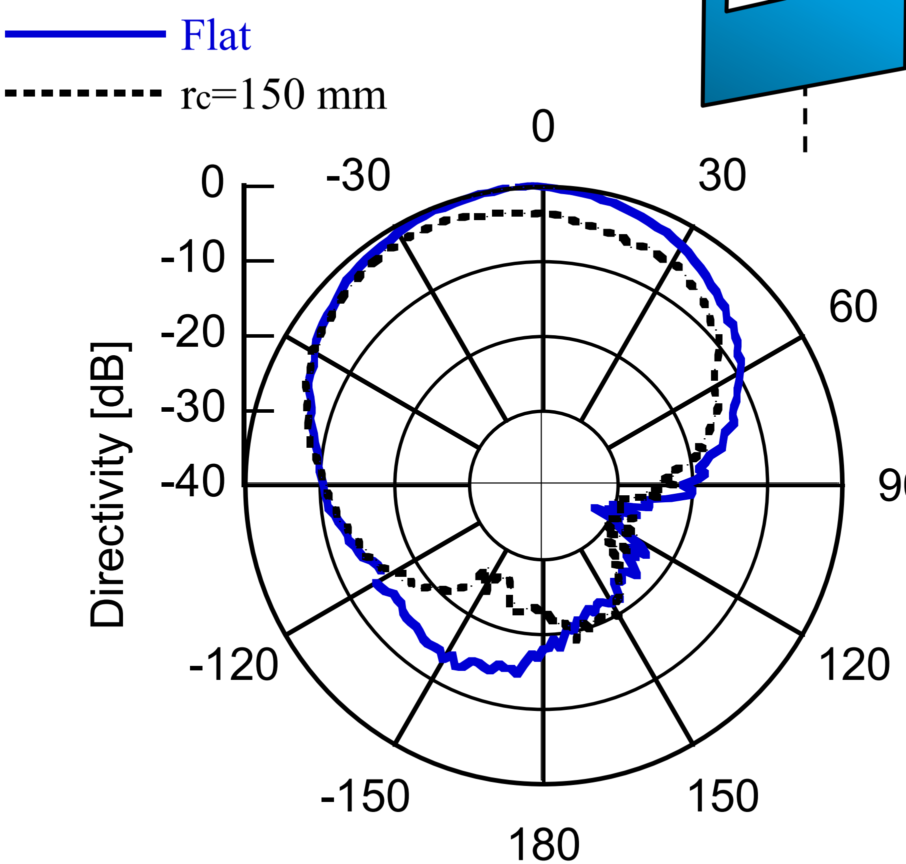


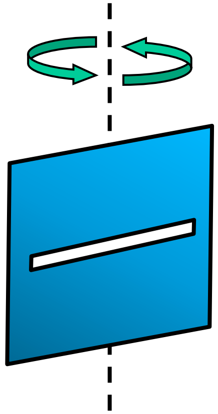


Radiation pattern (H-plane)

※Gain：1.94 dBi， Operation frequency：2.450 GHz







Experimental results

Compared with the taped case …

- Bandwidth → **wider**
- Center frequency → **less shifted**

Comparing their patterns in flat and bending cases …

→ The effects of bending on the radiation patterns were little when using the sewn feed line.

Conclusions

- We tried the feed line sewn to the CBSA.
- The antenna characteristics were measured and compared with those by the previous fixing method.
- The dependence on the curvature of the antenna in the sewing case was less than that by the previous method.

The antenna characteristics can be improved by the reduction of unnecessary deformation of the feed line and the antenna.

Future work

- Reduction of the cavity deformation
- Attachment to complex objects