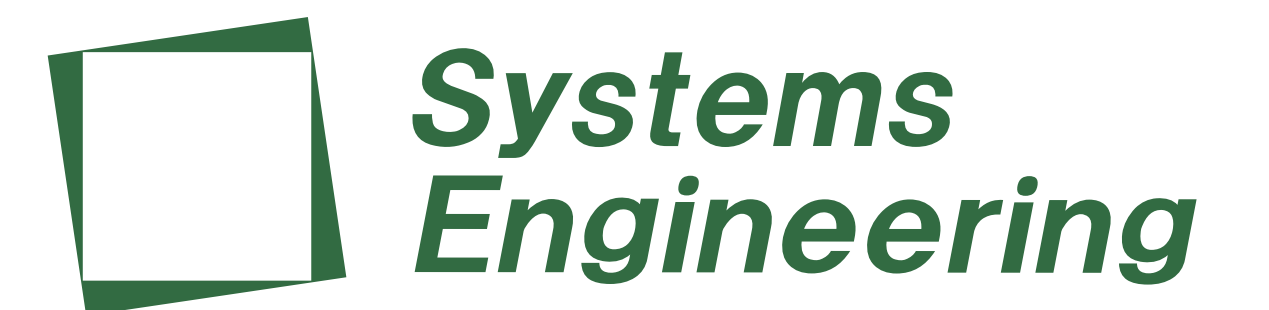


Infrared Analysis of Carbon-Rich Polymers Using Cantilever Enhanced Photoacoustic Detector

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Introduction

Carbon materials in industry

- have long been used for...
- High chemical stability
- Electrochemical stability

Even emerging demands

- e.g. Carbon-filled polymer electrode
- Flexible, mobile and conductive
- Can be used in displays and batteries

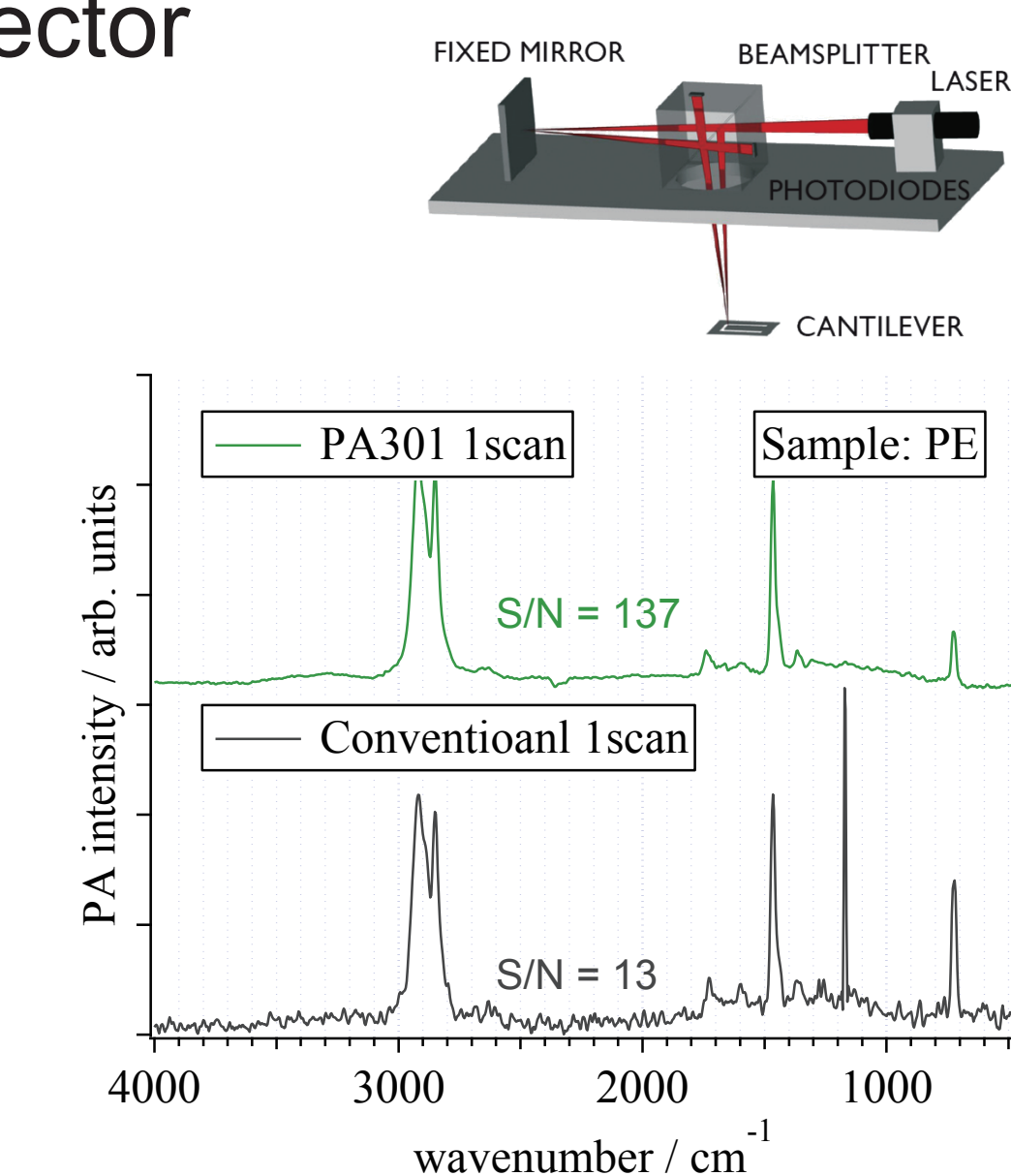
Spectroscopy of carbon-rich materials

- Transmission: Saturated due to large absorption
- Reflection: Distorted due to high refractive index
- PAS:
 - Less influenced by absorption and refractive index
 - × Longer accumulation time due to low sensitivity of the detector

Novel PAS detector (GASERA; booth 555)



- Cantilever and laser interferometer based detector
- Ten times more sensitive than microphone
- » 1/100 accumulation time!



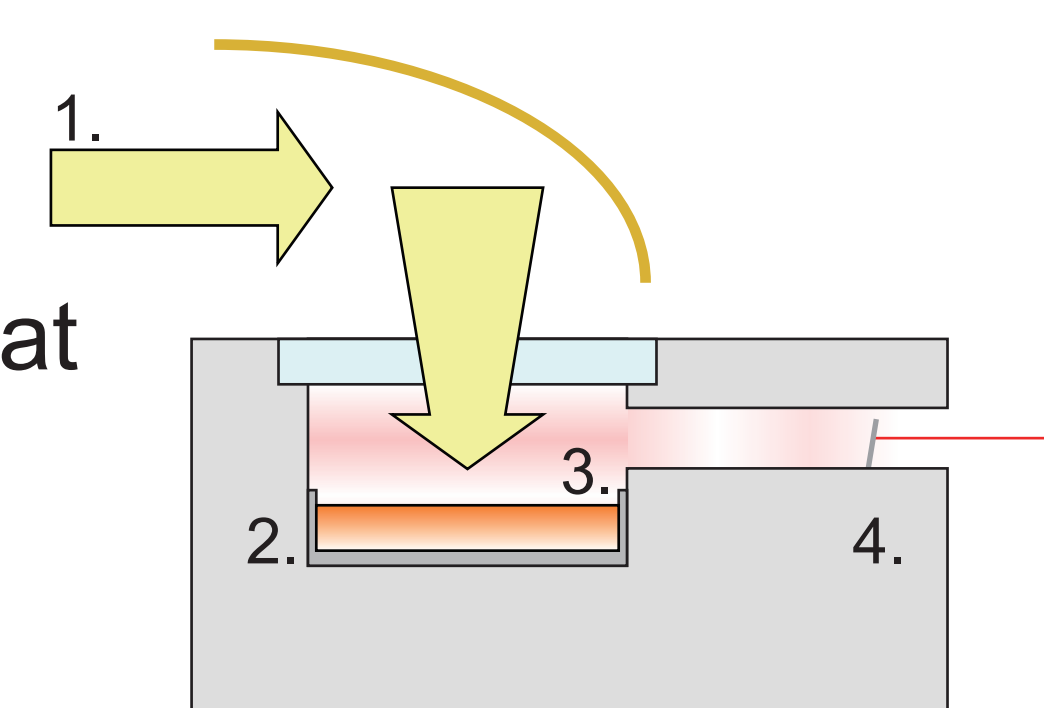
This study

- Quantitative study on PAS spectra of carbon-containing NBR
- Investigation of the detection limit of PAS with the cantilever detector

Photoacoustic Spectroscopy (PAS)

Photoacoustic spectroscopy

1. Sample absorbs incident light
2. Absorbed energy partially transformed into heat (non-radiating relaxation)
3. Heat diffuses back to sample surface
4. Thermal expansion of surrounding gas detected



PAS advantage

- Highly sensitive
- Non-destructive
- Depth-profiling
- Versatile
 - » Irregular shaped, small, or opaque sample etc.
 - » THz, IR, NIR, UV-Vis etc.

Experiment

FT-IR: Bio-Rad FTS575C

PAS detector: GASERA PA301

Measurement

Mirror speed: 2.5 kHz (0.1581 cm s^{-1}); Resolution: 4 cm^{-1} ; Gain: 0.1;
Accumulation: 32 or 256 scans

Sample¹

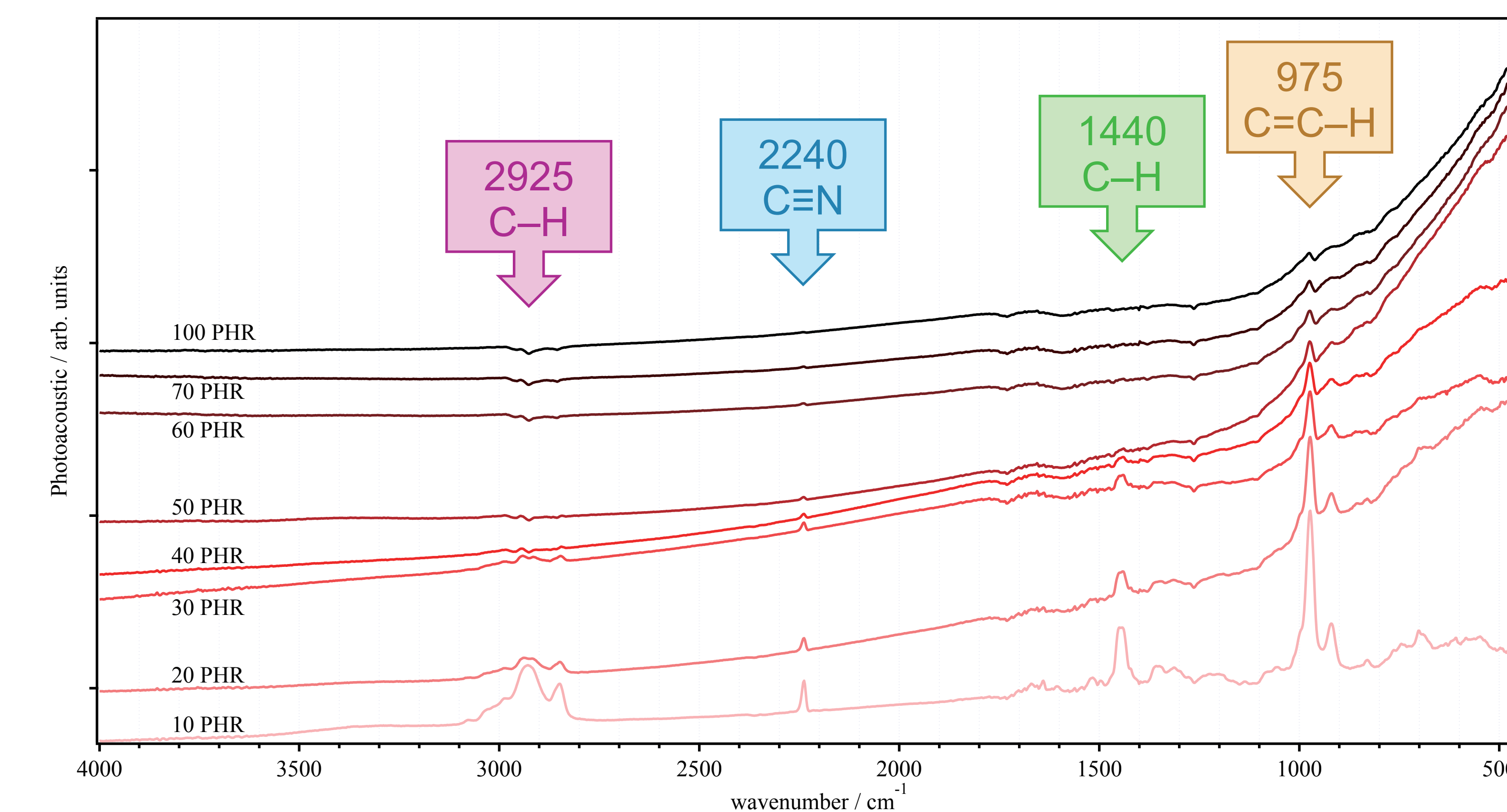
NBR Nipol® DN202 ²	100	100	100	100	100	100	100	100	100
Carbon FEF	0	10	20	30	40	50	60	70	100
Antioxidant Nocrac CD	0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Antioxidant Nocrac MBZ	0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Carbon %	0	8.8	16	23	28	33	37	40	49

¹ These compound samples were supplied by Zeon Corporation

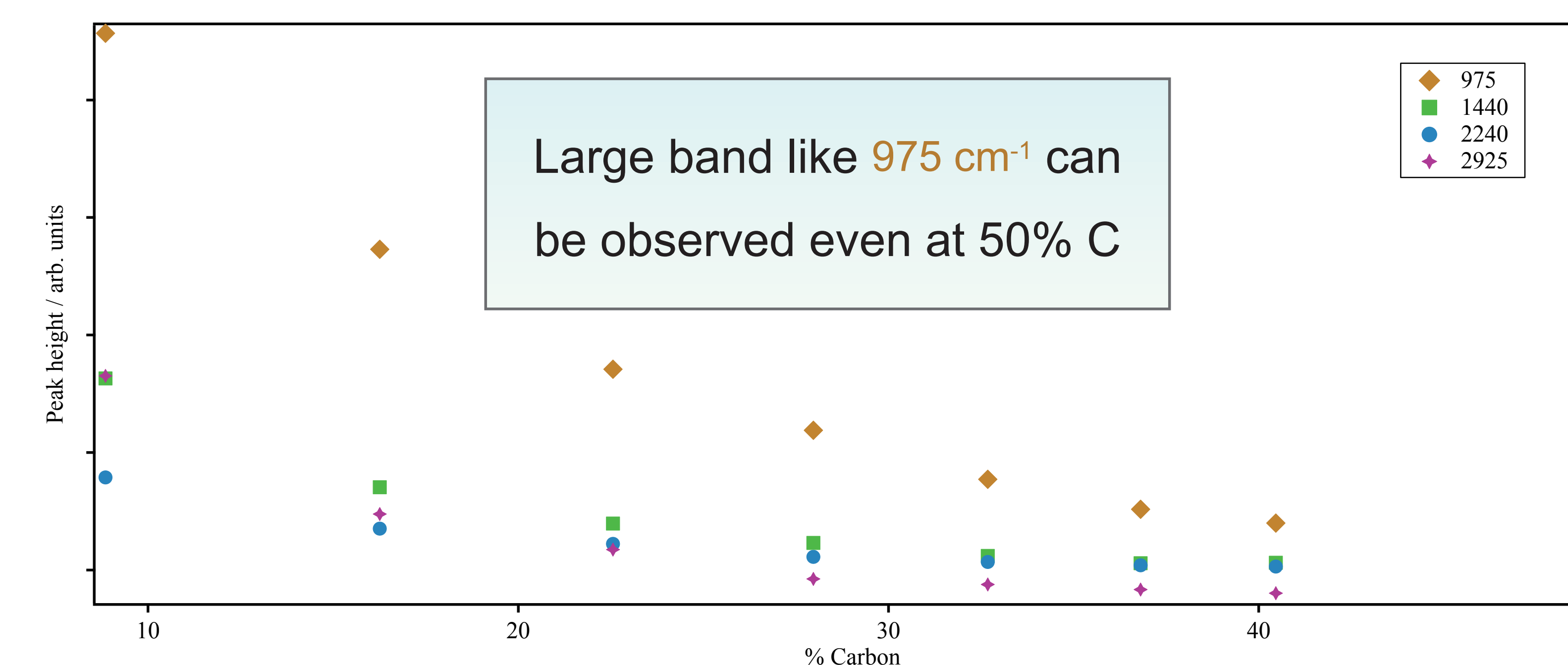
² Produced by Zeon Corporation

Results and Discussion

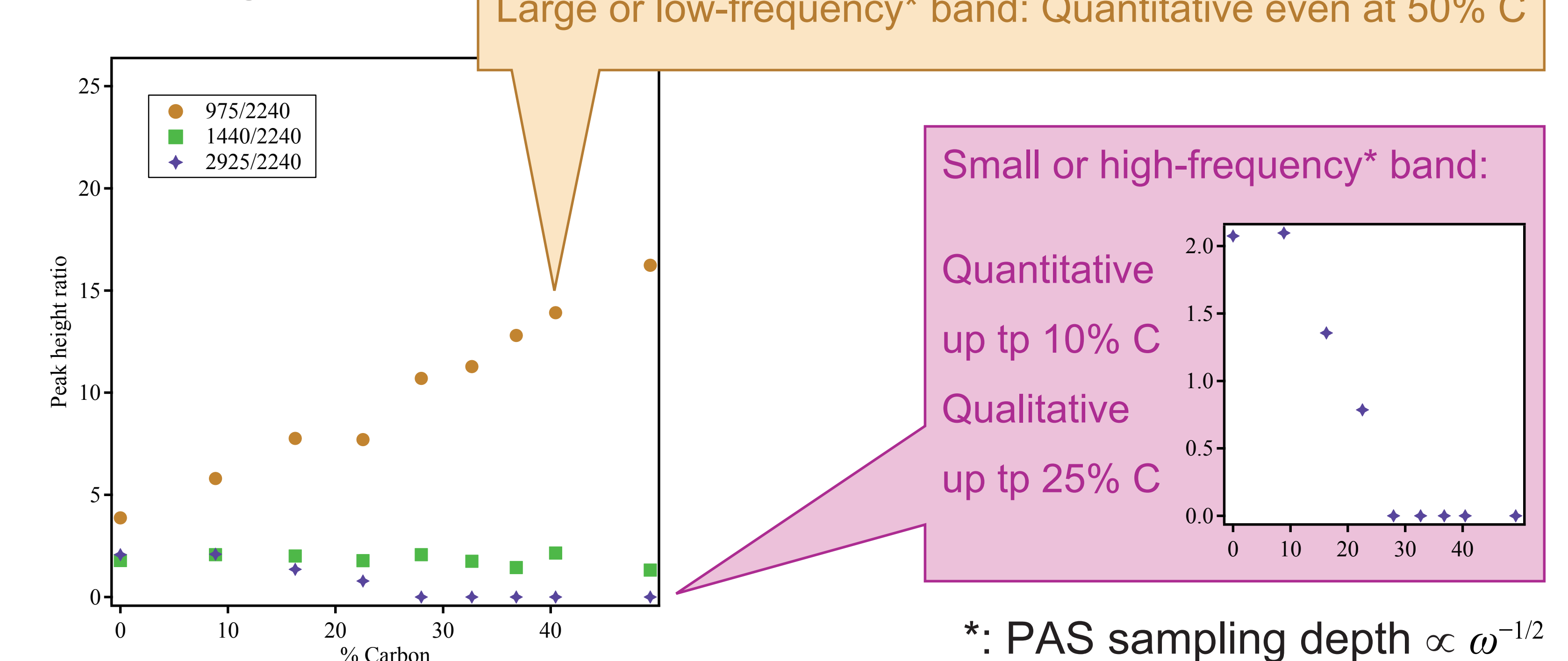
1. PAS spectra of carbon-containing NBR (256 scans)



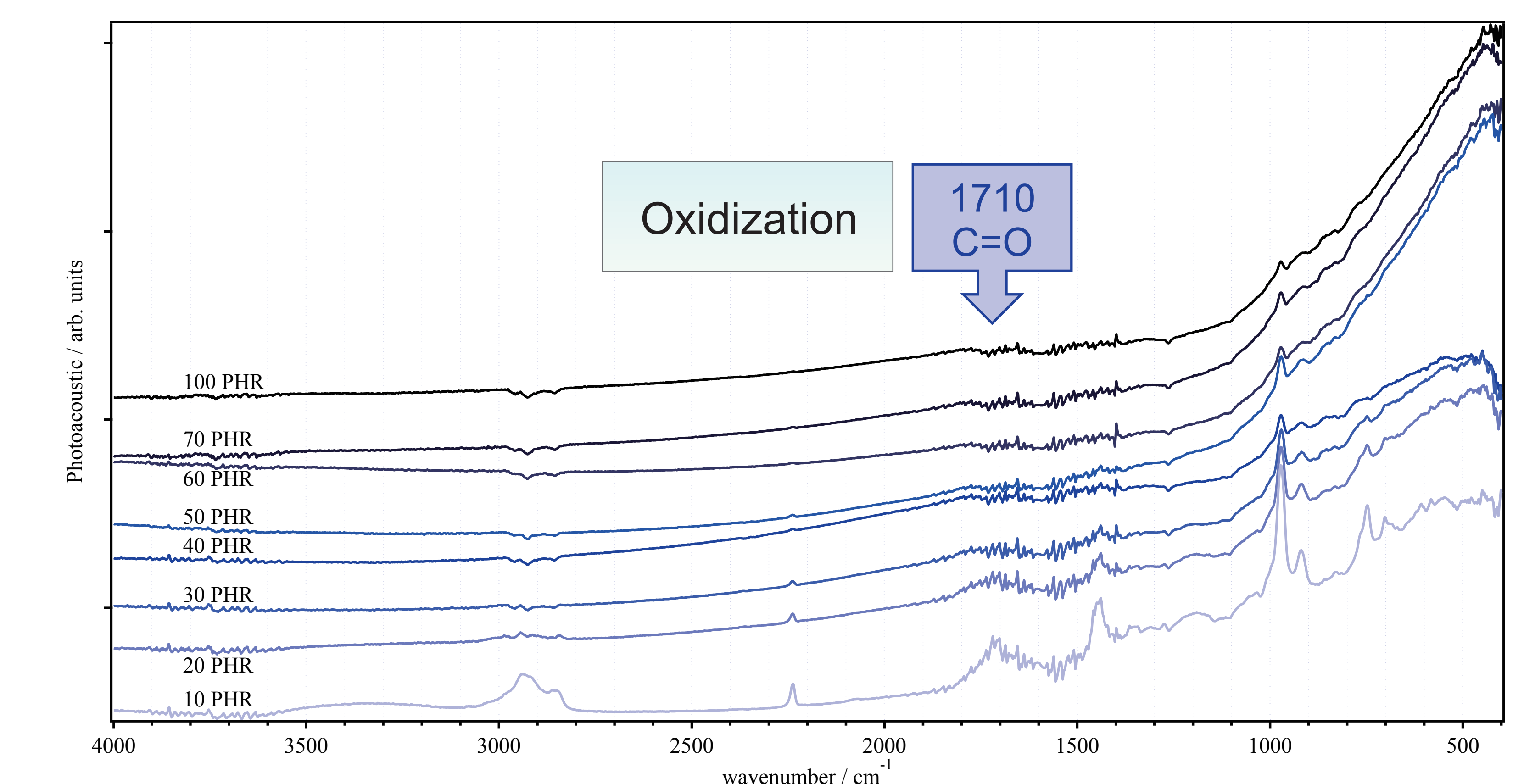
Peak height



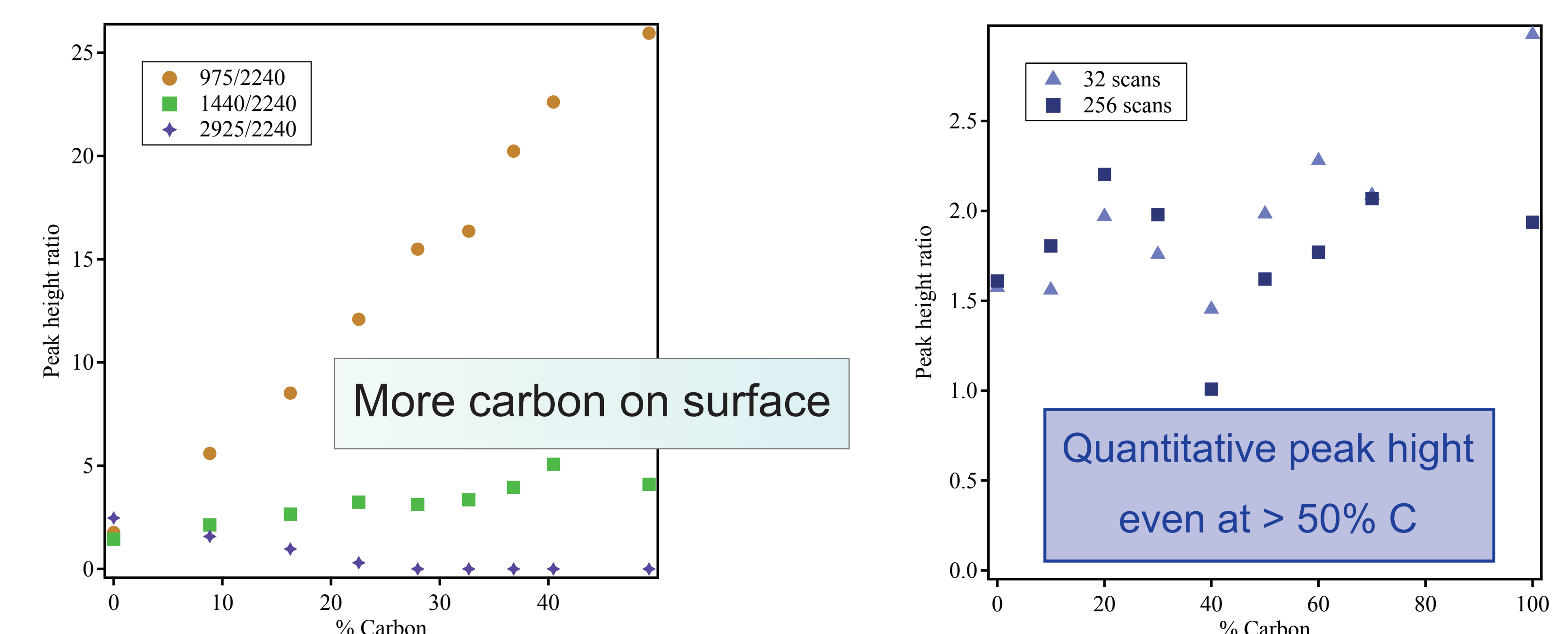
Peak height ratio



2. UV irradiated (96 hr) NBR (256 scans)



Peak height ratio



Conclusion

PAS detection limit of carbon-rich polymer has been investigated

Small or high-frequency band: Quantitative up to 10% C

Qualitative up to 25% C

Large or low-frequency band: Quantitative up to 50% C