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Application Note

Raman Analysis of Si Crytallinity

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Abstract

In this study B&W Tek *i*-Raman® with 532 nm excitation laser was used to analyze Si crystallinity in the mixed phase silicon films. The high resolution of *i*-Raman makes it an effective instrument to characterize the Raman peaks shifting as the crystallinity in the Si samples changes from amorphous to highly polycrystalline structure.

Introduction

B&W Tek *i*-Raman is unique for its high sensitivity, high resolution, as well as small footprint. It delivers the performance comparable to bench-top lab Raman systems while providing the versatility of field-portability and affordability. Current *i*-Raman family contains with two models: high resolution (H) and standard (S) with resolution of 3 cm^{-1} and 5 cm^{-1}, respectively.

Experiment Setup

i-Raman (S) with 532 nm excitation laser is used to measure Raman spectroscopy. B&W Tek Video Microscope Sampling System (BAC151A) is used to facilitate the measurement. Figure 1 shows the experiment setup of *i*-Raman and the Video Microscope Sampling System.

i-Raman

BAC151A

Samples

Two groups of samples are used for the experiment. The samples are silicon deposited on glass substrate with various Si crystallinity rate.

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Group A contains samples with wide crystallinity rate. #1a and #2a have crystallinity rate under 10%. #3a has crystallinity between 40% and 60%. #4a has crystallinity higher than 90%; #5 is single silicon.

Group B contains samples with relatively narrower range of crystallinity. The crystallinity rate in #1b, #2b, #3b are between 40% - 60%.

Results and Discussions

Two Raman peaks are related to silicon crytallinity: peak at 480 cm^{-1} is associated to the amorphous phase. Peak 520 cm^{-1} is originated from microcrystalline Si.

Figure 1 overlays the Raman spectra from samples in Group A, and Table 1 shows the sample information for Group A. The shifting of peak 480 cm-1 to peak 520 cm-1 can be seen from Figure 1. As silicon crytallinity increases, the amorphous peak 480 cm^{-1} reduces while the microcrystalline silicon peak 520 cm^{-1} emerges.

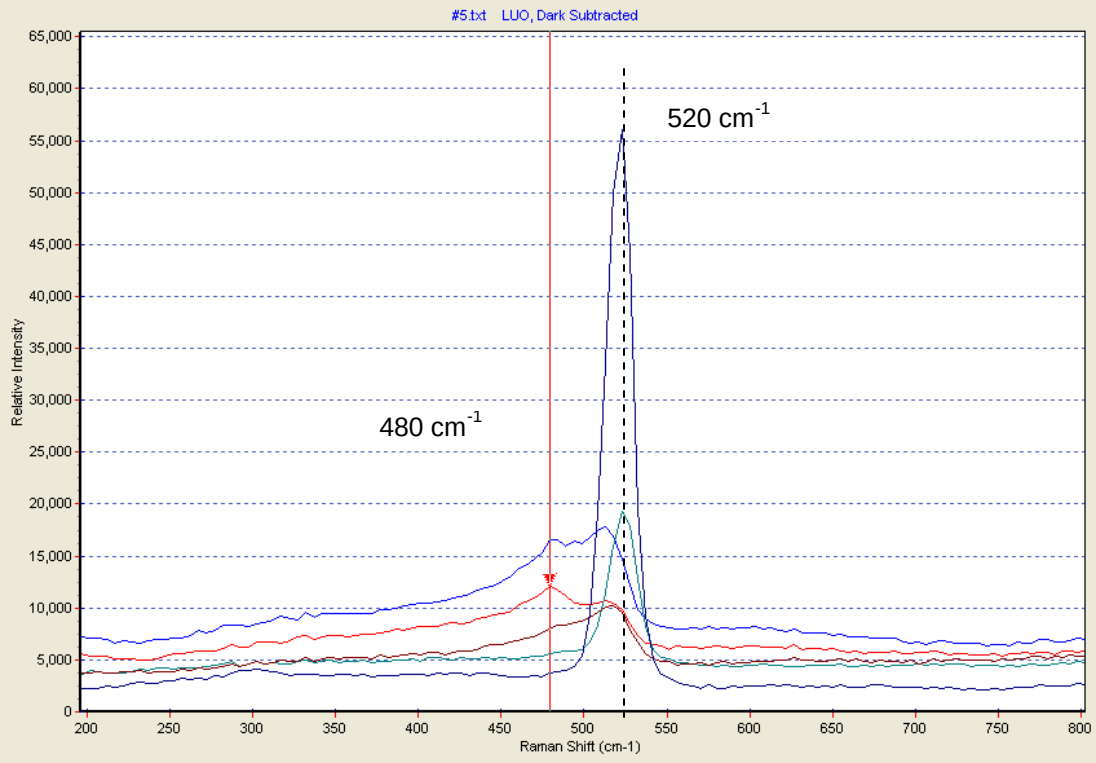

Figure 1

Table 1

Sample	#1a	#2a	#3a	#4a	#5
	Red	Blue	Brown	Green	Dark blue
Crystallinity	<10%	<10%	40% - 60%	>90%	Single Crystal Si

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Figure 2 shows the overlay of Raman spectra from samples in Group B. Sample information for Group B is shown in Table 2. The fact that peak 480 cm^{-1} is weaker than peak 520 cm^{-1} for all three samples in Group B is due to the crystallinity rates in this group between 40% and 60%. Comparing to Figure 1, there are less variation from peak 480 cm^{-1} to peak 520 cm^{-1} because of the narrow range of silicon crystallinity in this sample group.

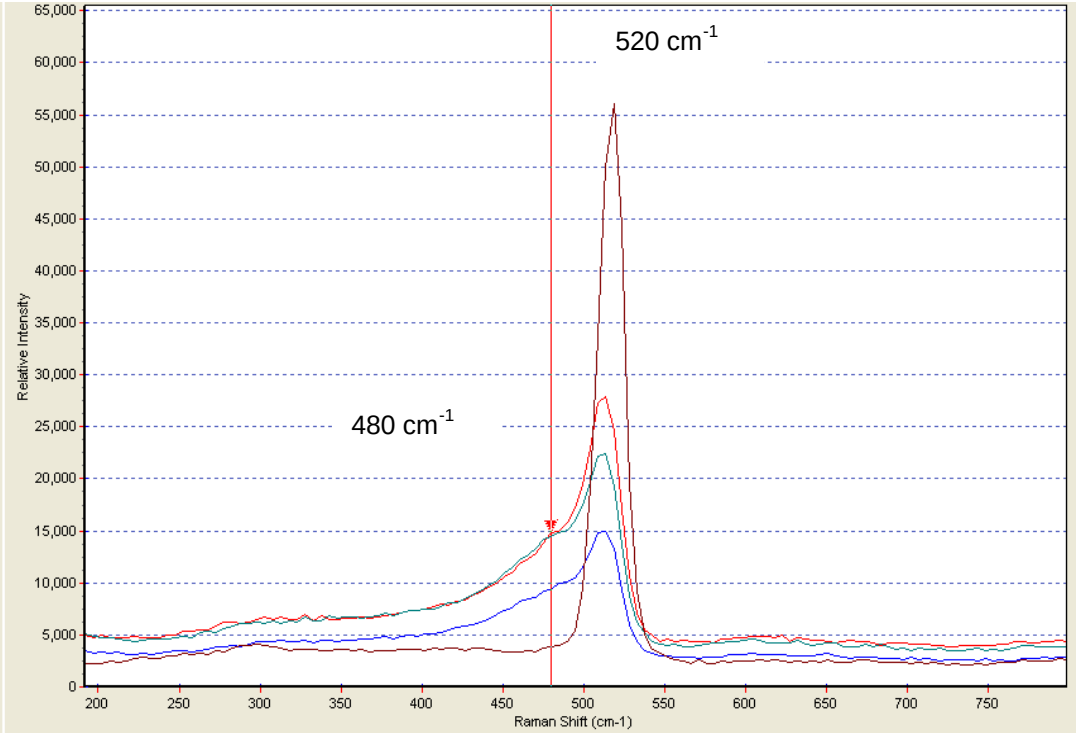

Figure 2

Table 2

Sample	#1b	#2b	#3b	#5
	Blue	Red	Green	Brown
Crystallinity Rate	45%	55%	63%	Single crystal Si

Conclusions

B&W Tek *i*-Raman with 532nm laser excitation, coupled with Video Microscope Sampling System, is an effective Raman spectrometer system for Si crystallinity analysis.