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SUM FREQUENCY GENERATION OF POLYSACCHARIDES

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Sum frequency vibrational spectroscopy (SFVS) is as an excellent tool in study of vibrational modes of functional groups in organic materials with higher selectivity and sensitiveness than many other spectroscopies. Based on these advantages, I carried out my study by using SFVS to measure the CH stretching vibrational spectra of polysaccharides including maltose, amylopectin from rice (EM-21), dextrin, phytoglycogen from mutant of rice and glycogen from oyster. This is the first time that SFVS experiments applied on these materials. From their spectra, I found results below.

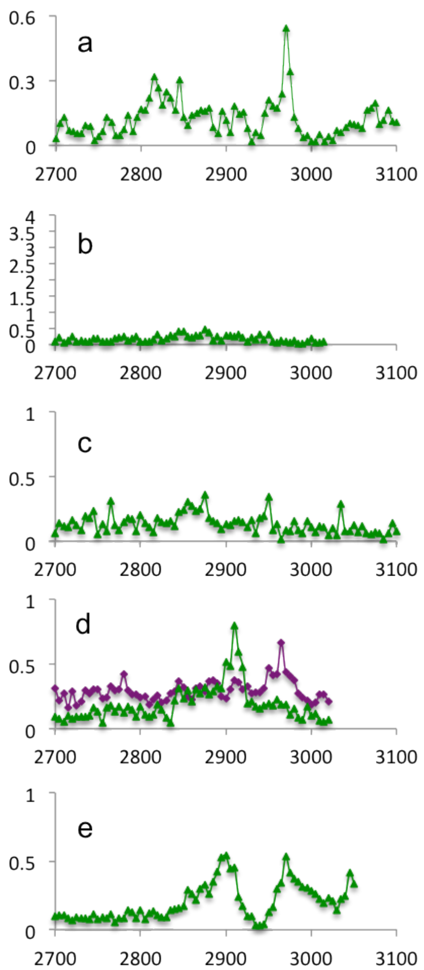

Fig.1. SFG spectra of polysaccharides. (a): Maltose, (b): Dextrin, (c): Phytoglycogen, (d): Amylopectin from rice (EM-21), (e): Glycogen from oyster

Maltose (a) generates very strong SFG signal with the highest peak at 2970 cm^{-1} assigned to the in anti-phase condition of two CH_2 groups. The shoulder at 2950 cm^{-1} might be caused by the in phase condition of two CH_2 groups.

Because dextrin (b) does not emit SFG signal, it was suggested its double helix structure may be randomly oriented or macro inversion symmetric. Phytoglycogen (c) is similar due to no SFG signal but luminescence. Therefore, it has high order structural micro-symmetric structure.

Amylopectin from rice (EM-21) (d) shows a very weak SFG signal with two dominant peaks at 2910 and 2965 cm^{-1}. This kind of amylopectin is far different from other kinds of amylopectin in maize that was studied before by some researchers in our laboratory. This distinguish suggests us that the difference in branching distribution and the number of branches is the reason.

In case of glycogen from oyster (e), it emits relatively strong SFG signal with two peaks around 2910 and 2965 cm^{-1} like amylopectin from maize. It might be that glycogen has similar structure with amylopectin from maize. However, the branches in glycogen were studied to be more random and highly distributed than amylopectin from maize. Therefore, the SF intensity of glycogen is much weaker than amylopectin from maize.

In conclusion, SFVS is sensitive to CH stretching modes and has a good selectivity in vibrational spectra of the asymmetric and chiral molecules such as glucose, fructose, sucrose, maltose and glycogen. The asymmetric vibrational mode of CH_2 becomes dominant in almost saccharides that can emit SFG. In contrast, SFG is forbidden in the media like double helix structural dextrin or high order structural micro-symmetric phytoglycogen. Even though these are the first SFG spectra of some polysaccharides in the world, I hope they will be investigated deeply in near future and SFVS will be applied more and more in biotechnology and other fields.

Key words: Sum frequency generation, polyssacharides, nonlinear optics, chiral molecule.