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Investigation of the presence of pesticides on fruits via plasmonically enhanced Raman spectroscopy

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1. Introduction

Widespread use of pesticides in agriculture has resulted in high yield and quality of the food crops, however, with harmful effects on human and other living creatures, this has caused a great concern, and the researchers are looking for a suitable technique to detect pesticides on food, even when they are in low concentration. Raman spectroscopy is a powerful, sensitive and nondestructive way to detection pesticides, but it is difficult to detect Raman signal when concentration of pesticides is ultra low. To overcome this problem, plasmonic technique can be used to enhance the weak Raman signal to detect ultralow level of pesticides [1].

2. Experiments and Results

Here, we report an approach based on plasmonic enhancement, which is rapid, nondestructive and sensitive for pesticides detection, named particle enhanced Raman spectroscopy (PERS). In this technique, Raman signal is enhanced via the resonant excitation of localized plasmons in metallic nanoparticles. As the plasmonic resonance wavelength highly depends on the shape, size and material of nanostructures, it is possible to grow a particular type of nanoparticles that would match the plasmon resonance frequency for any desired excitation wavelength with very good accuracy [2].

Gold is one of the promising materials that has plasmon resonance in visible to near-IR, which depends on shape and size of nanostructures. In our work, we synthesized gold nanospheres and gold nanorods (GNRs) with various sizes by using seed mediated growth method [3]. Gold nanospheres with average diameter 20nm showed plasmon resonance at 530nm. Subsequently, GNRs showed plasmon resonance that could be tuned from 600nm to 1000nm by changing the length of GNRs, as shown in Fig. 1.

For our experiment, we used gold nanorods that has plasmon resonance at 780nm, close to the excitation wavelength of 785nm used for Raman measurements of Benomyl pesticide.

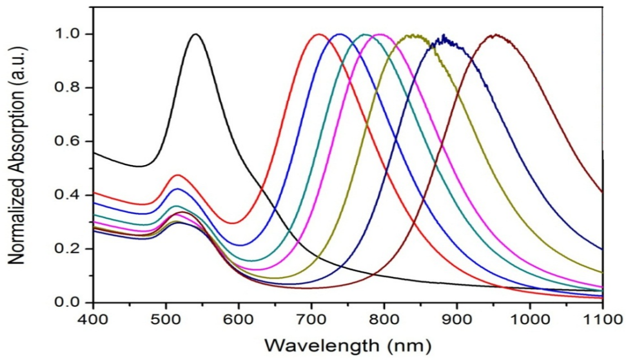

Fig. 1 UV-vis spectra of gold nanostructures at different silver ion concentration

We sprayed the pesticide solution on the Orange and flushed it several times by DI water and measured Raman spectrum (Fig 2(a)) which shows no peaks related to the pesticide, which is because of the ultralow concentration after the wash. We then dropped gold nanorods solution and detect the Raman spectra again (Fig 2 (b)). As indicated by the arrows, here we can clearly see the excitation of a few Raman peaks corresponding to the pesticides.

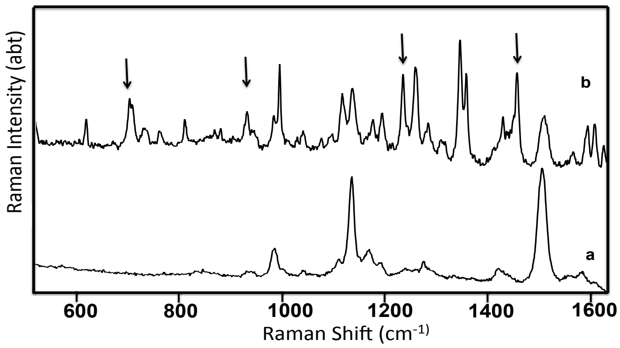

Fig. 2 The Raman spectra of (a) orange and pesticides, (b) Orange, Pesticides and gold nanorods.

3. Conclusions

Here, we successfully detected ultra low concentration pesticide residues on fruits using our PERS technique, which was not detected by normal Raman technique.

References

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