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A novel surface-enhanced Raman scattering (SERS) detection for natural gas exploration using methane-oxidizing bacteria

Weiwei Liang[1], Qiao Chen[1,2], Fang Peng[3], Aiguo Shen[1,*], Jiming Hu[1]

[1]Key Laboratory of Analytical Chemistry for Biology and Medicine (Ministry of Education), College of Chemistry and Molecular Sciences, Wuhan University, Wuhan 430072, China

[2]Chemical college, Leshan Normal University, Leshan 614000, China

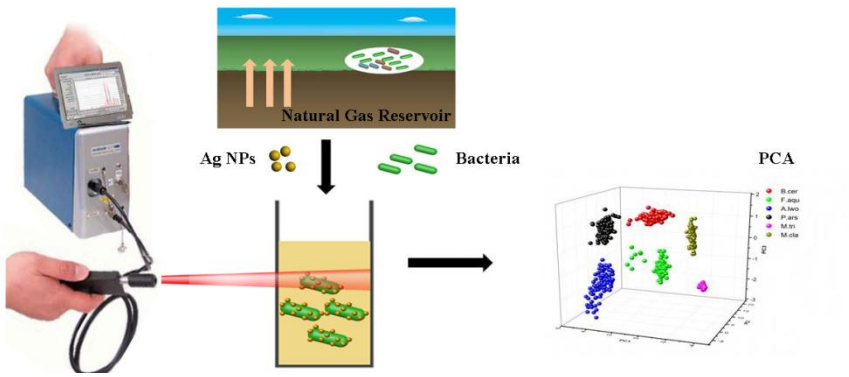
[3]China Center for Type Culture Collection, Wuhan University, Wuhan 430072, China

[*]Corresponding Author: E-mail: agshen@whu.edu.cn

ABSTRACT

Methane-oxidizing bacteria (MOB), a unique group of Gram-negative bacteria utilizing methane as a sole source of carbon and energy, have been proved to be a biological indicator for gas prospecting. Field and cultivation-free detection of MOB is important but still challenging in current microbial prospecting of oil and gas (MPOG) system. Herein, SERS was used for the first time to our knowledge to investigate two species of methanotrophs and four closely relevant bacteria that universally coexisted in the upper soil of natural gas. A special but very simple approach was utilized to make silver nanoparticles (Ag NPs) sufficiently contact with every single bacterial cell, and highly strong and distinct Raman signals free from any native fluorescence have been obtained, and successfully utilized for distinguishing MOB from other species. A more convincing multi-Raman criterion based on single Raman bands, and further the entire Raman spectrum in combination with statistical analysis (*e.g.*, principal component analysis (PCA)), which were found capable of classifying MOB related bacterial cells in soil with an accuracy of 100%. This study therefore demonstrated sensitive and rapid SERS measurement technique accompanied by complete Raman database of various gas reservoirs related bacteria could aid field exploration of natural gas reservoir.

Graphical Abstract



Keywords: SERS, Bacterial distinction, MOB, PCA, Natural gas prospection

1. Introduction

Natural gas is formed under soil and chiefly composed of methane and a small amount of ethane, comes into