铁电基表面增强拉曼散射连续可逆调控研究

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表面增强拉曼散射 (SERS) 是一种强大的指纹分析检测技术，在食品安全、环境保护、生物成像及危险物质识别等领域发挥着重要作用。然而，现有技术调控困难且不可逆，一定程度上限制了 CM 基 SERS 基底的应用。因此，如何实现基底-分子系统的能级耦合的灵活、可逆调控，还有待进一步的探究。

山东师范大学满宝元教授团队的李振副教授、张超教授与浙江大学的徐凯臣研究员合作，提出了一种基于铁电效应灵活、可逆调控 SERS 化学增强的策略，实现了不同激发波长下对不同能带结构分子的超灵敏普适检测。在铁电材料中，由极性堆叠引起的净电荷会被表面重构、移动电荷以及吸附材料所钝化，这使得调控其表面二维材料的电子结构成为可能。

研究人员首先通过控制铁电铌镁酸铅-钛酸铅 (PMN-PT) 的极化方向，实现了表面吸附氧化石墨烯费米能级的大范围调控。在此基础上，验证了铁电效应对 SERS 检测过程中化学增强调控的普适性。总之，在不同的铁电极化方向和极化强度下，可以对氧化石墨烯的费米能级进行灵活、可逆调控，并基于同一基底实现了对不同能带结构分子的高灵敏 SERS 检测，有效地解决了 CM 基 SERS 基底的普适性问题。

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Ferroelectric-based continuous reversible modulation of surface-enhanced Raman scattering

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Surface-enhanced Raman scattering (SERS) is a powerful fingerprint analysis and detection technique that plays an important role in the fields of food safety, environmental protection, bio-imaging and hazardous substance identification.

The research group of Prof. Baoyuan Man from Shandong Normal University introduces a new strategy to flexibly and reversibly modulate the chemical enhancement of SERS based on the ferroelectric effect, realizing the ultra-sensitive universal detection of molecules with different band structures at different excitation wavelengths. In ferroelectric materials, the net charge induced by polar stacking is passivated by surface reconstruction, mobile charges and adsorbed materials, which makes it possible to modulate the electronic structure of the two-dimensional materials on their surfaces.

The researchers first achieved large-scale modulation of the Fermi level of surface-adsorbed graphene oxide by controlling the polarization direction of ferroelectric lead magnesium niobate-lead titanate (PMN-PT). Based on this, they also verified the universality of the ferroelectric effect for the modulation of chemical enhancement during SERS detection.

In conclusion, the Fermi level of graphene oxide can be flexibly and reversibly tuned under different ferroelectric polarization directions and polarization strengths, and the highly sensitive SERS detection of molecules with different band structures has been achieved based on the same SERS substrate, which effectively solves the universality problem of CM-based SERS substrates.

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