화학과 대학원 세미나

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Development of In-Situ Analytical Methods using Optical and Chemical Raman Enhancement

Raman spectroscopy is a nondestructive method widely used in various scientific disciplines to provide chemical information through vibrational structure. However, its application is limited by its low scattering cross-section compared to other methods. In our research, we have developed optical and chemical enhancement methods to improve the intrinsic scattering cross-section and instrumental collection efficiency of Raman spectroscopy. Firstly, we investigated the correlation between Raman scattering and fluorescence emission on painted artworks in solid state using resonance Raman and optical pumping Raman spectroscopy. Secondly, we attempted to increase the Raman efficiency using surface-enhanced Raman spectroscopy (SERS) and quantified the SERS signal by a high-speed scanning method. To minimize measurement errors from the heterogeneity of nano-structures and local sample densities, flexible SERS substrates were equipped on a spiral scanning instrument. Finally, we developed a hyperspectral deep Raman method that provided improved Raman collection efficiency from concealed subsurface components and applied our method to the physicochemical analysis of pharmaceutical and agricultural products. Additionally, we combined machine learning and artificial neural network algorithms with our instrumental system for automated Raman detection of numerous chemicals and biological components.

References

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김 형 민 교수
국민대학교 응용화학부