Abiotic Degradation of Triazine Pesticides Analyzed with Surface-enhanced Raman Scattering

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Triazine herbicides are considered among the most important class of agricultural chemicals ever developed. During their 50 years of use they have contributed to the huge increment of the crop production. Atrazine is by far the most employed triazine pesticide because of its high flexibility in combined treatments [1]. This herbicide continues to be widely used today in USA, but it was banned in EU from 2003 [2]. One of the most interesting chemical characteristics of triazine pesticides is its high tendency to degradation by several factors: hydration, photolysis, temperature. In general, it is widely considered that these degradation processes are enhanced at extreme pH's, mainly at acidic one. The most frequently detected atrazine degradation products are DEA (des-ethyl atrazine) and DIA (des-isopropyl atrazine), but also the hydroxylated degradation products are considered the major degradation products. These products are also common to other triazines structurally related to atrazine such as simazine or prometryne. Therefore, the possible detection of triazine herbicides in water (lakes, rivers, etc.), related to the agricultural practices, by SERS (Surface-enhanced Raman scattering) must take into account all these effects. Of course, always considering the possible catalytic effect caused on the pesticide structure by the metal surface.

In this work we present the preliminary results obtained in our laboratory on the detection of atrazine and prometryne by using different SERS substrates: Ag and Au nanoparticles (spherical and nanostars), as well as Ag films obtained by pulsed-laser deposition (PLD). The results obtained from these experiments revealed several important facts: a) the commercial triazine compounds presented a partial degradation; b) the SERS cross section of the degraded triazines is ca. two orders of magnitude higher than the precursor original triazine; and c) these herbicides display a high tendency to the degradation at relatively mild conditions, such as the increase of temperature under aqueous solution. A comparison of the SERS spectra of the degradation compounds with the theoretical spectra and the commercial products was carried out in order to properly assign the corresponding compounds detected by SERS.

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References