

纳米金胶对化学发光体系的影响及其应用

摘 要

本文首先在文献调研的基础上,对化学发光分析法的研究现状及进展,以及纳米材料在分析化学中的应用作了综述。

本文发现通过 HAuCl_4 的还原所制备的纳米金胶可以有效地增强鲁米诺(Luminol)– H_2O_2 体系的化学发光,并且不同粒径的纳米金胶增强效果不同。通过实验发现粒径为 $38.7 \pm 4.2 \text{ nm}$ 的纳米金胶对该体系的增强效果最强。通过对谱图的分析,发现该化学发光过程中发光体没有改变,仍然是3-氨基邻苯二甲酸根离子,所以推断纳米金胶增强该体系化学发光的机理为:由于纳米金胶表面具有高的活性,它容易与Luminol的氨基结合,通过表面等离子体的偶合作用而产生电子部分转移,促进发光体的生成,使化学发光强度增强。在此基础上,本文利用纳米金胶–Luminol– H_2O_2 化学发光体系测定了邻苯二酚、抗坏血酸、肾上腺素、去甲肾上腺素、多巴胺、组氨酸和L-半胱氨酸,得到优于文献报道的线性范围和检测限,为这类物质的检测提供了新的方法。并提出了利用该法检测此类物质的反应机理,认为此类物质或者能与Luminol竞争结合纳米金胶,或者能与Luminol竞争 H_2O_2 发生氧化反应,或者两者兼有。

纳米金的这种催化作用还有可能应用于其它更多的化学发光体系。

Effects of Gold Colloids on Chemiluminescent systems and their applications

Abstract

On the basis of literature, present investigation and development in the field of chemiluminescence (CL) and the application of nanoparticles in analytical field are reviewed.

It was found that gold colloids synthesized by the reduction of HAuCl_4 could effectively enhance the chemiluminescence of luminol by the oxidation of hydrogen peroxide and different size of gold colloids exhibited different effect, while gold colloids with diameter of $38.7 \pm 4.2 \text{ nm}$ gave the best result. After more analysis, we found the emitter of this chemiluminescent reaction stayed the same and it was the excited state of 3-aminophthalate ion. We concluded its mechanism as follow: gold colloids had great surface activity so that they could combine with $-\text{NH}_2$ on luminol and the coupling of nanogold surface plasma with the partially transferred electric charges would promote the formation of emitter, and enhance the chemiluminescence finally. Then, on the basis of the system above, we measured seven useful compounds including catechol, ascorbic acid, adrenalin, noradrenalin, dopamine, histidine and L-cysteine. As a result, we got wider linear ranges and lower detection limits, superior to methods in literature. We thought the reaction process may be that they could compete with luminol for combination with gold colloids, or for hydrogen peroxide, or both of them.

The catalysis effects of gold colloids may be also applied in other chemiluminescent systems.