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微纳技术与精密机械

采用脉冲电晕放电离子源的离子迁移谱仪

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摘要: 尝试采用脉冲电晕放电作为离子迁移谱仪中的放射性离子源以简化离子迁移谱仪结构。研究了脉冲电晕放电的特性, 测量了单次脉冲电晕放电产生的正离子数, 以及正离子数与高压脉冲的关系, 正离子数与电极间距的关系以及在不同针尖曲率半径下, 正离子数随高压脉冲的变化。确定脉冲电晕放电离子源的各电极参数后, 设计了脉冲电晕放电离子源及相应的离子迁移谱仪主体结构。最后, 利用自行设计的离子迁移谱仪, 探测了空气中反应物离子 $H+(H_2O)_n$ 的迁移谱。结果显示: 离子迁移谱的峰值对应时间为47.5 ms, 峰值半高宽为7.5 ms, 由此算出离子迁移谱仪的谱分辨率为6.33。实验验证了脉冲电晕放电作为离子迁移谱仪离子源的可行性。由于脉冲电晕放电结构极易采用微机电系统(MEMS)技术实现, 其对应的迁移管和传统迁移管相比去除了离子门, 简化了离子迁移谱仪的结构。

关键词: 离子迁移谱仪 离子源 脉冲电晕放电 微机电系统

Ion mobility spectrometer using pulse corona discharge ion source

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Abstract: The pulse corona discharge was employed as the ion source of an Ion Mobility Spectrometer (IMS) to replace the radioactive ion source to simplify the structure of the IMS. The features of pulse corona discharge was researched and the Number of positive Ions(Ni) in a single pulse corona discharge were measured. Then the relationships between the Ni and the high voltage pulse, the Ni and the electrode spacing, and the variation of NIs with high voltage pulse under different tip curvature radii were tested. After determining the electrode parameters of pulse corona discharge ion source, the pulse corona discharge ion source and the corresponding main structure of IMS were designed. Finally, the mobility spectrum of reactant ion $H+(H_2O)_n$ in the air was detected by using the IMS built in our lab. The obtained results show that the time corresponding to the peak of IMS is 47.5 ms, and the peak half-width is 7.5 ms. Therefore, the spectrum resolution of IMS for reactant ion $H+(H_2O)_n$ detection is 6.33. The experiments demonstrate it is feasible that pulse corona discharge is used as the ion source of IMS. Because the structure of pulse corona discharge can be easily realized using Micro-electronic-mechanic System(MEMS) technology, and its corresponding mobility pipe removes ion gate, the structure of IMS is simplified.

Keywords: Ion mobility spectrometer Ion source Pulse corona discharge Micro-Electro-Mechanical Systems (MEMS)

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