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激光溅射金属等离子体与醇类分子束反应的研究: 产物离子对分子束状态的依赖性

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摘要 用激光溅射-分子束方法在飞行时间质谱仪上研究了激光溅射金属等离子体与甲醇、乙醇团簇的反应, 观察到产物团簇离子对分子束性状的明显依赖性。当等离子体作用于脉冲分子束中较低密度的部分时, 金属-醇类复合团簇离子 $M^+A_n$  ( $M=Cu, Al, Mg, Ni$ 及 $A=C_2H_5OH,$

$CH_3OH$ ) 为主要产物,且团簇尺寸较小。当等离子体作用于束中较高密度部分时,

主要产物离子为质子化醇类团簇离子 $H^+A_n$ , 以及(当与甲醇反应时)质子化水合团簇离子 $H_3O^+(CH_3OH)_n$ ,

尺度较大(对乙醇 $n\leq 12$ , 对甲醇 $n\leq 24$ )。类似地, 当载气氦气压从 $1\times 10^5$ 帕上升至 $5\times 10^5$ 帕时,

主要产物离子从金属复合离子 $M^+A_n$ 转为质子化醇类离子 $H^+A_n$ ,

而且团簇尺寸也在增大。这种变化被认为是由于离子的不同产生机制引起的,

即 $M^+A_n$ 主要由金属离子与醇类团簇反应生成, 而 $H^+A_n$ 主要由电子与醇类团簇碰撞反应生成。

关键词 [金属等离子体,醇类团簇,激光溅射,飞行时间质谱](#)

分类号

## Reactions of Laser Ablated Metal Plasma with Molecular Alcohol Beams: Dependence of the Produced Cluster Ion Species on the Beam Condition

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**Abstract** The gas phase reactions of metal plasma with alcohol clusters were studied by time of flight mass spectrometry (TOFMS) using laser ablation-molecular beam (LAMB) method. The significant dependence of the product cluster ions on the molecular beam conditions was observed. When the plasma acted on the low density parts of the pulsed molecular beam, the metal-alcohol complexes  $M^+A_n$  ( $M=Cu, Al, Mg, Ni$  and  $A=C_2H_5OH, CH_3OH$ ) were the dominant products, and the sizes of product ion clusters were smaller. While the plasma acted on the high density part of the beam, however, the main products turned to be protonated alcohol clusters  $H^+A_n$  and, as the reactions of plasma with methanol were concerned, the protonated water-methanol complexes  $H_3O^+(CH_3OH)_n$  with a larger size ( $n\leq 12$  for ethanol and  $n\leq 24$  for methanol). Similarly, as the pressure of the carrier helium gas was varied from  $1\times 10^5$  to  $5\times 10^5$  Pa, the main products were changed from  $M^+A_n$  to  $H^+A_n$  and the sizes of the clusters also increased. The changes in the product clusters were attributed to the different formation mechanism of the output ions, that is, the  $M^+A_n$  ions came from the reaction of metal ion with alcohol clusters, while  $H^+A_n$  mainly from collisional reaction of electron with alcohol clusters.

**Key words** [metal plasma](#) [alcohol cluster](#) [laser ablation](#) [time of flight mass spectrometry](#)

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