The High Efficiency Cavity Source for Isotopic Analysis of Small Samples

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The High Efficiency Cavity Source (HECS) is designed as an alternative to traditional filament sources for thermal ionization mass spectrometry (TIMS), to enable much higher ionization efficiency. This is particularly critical for situations where sample is limited, and hence ionization efficiency places limits on the precision and accuracy of isotope ratio measurements. In the HECS source, the sample is loaded in a cavity bored into a metal (tungsten or rhenium) rod, which is heated by electron impact. The source's confined geometry and ability to operate at much higher temperatures provide the potential for enhanced ionization efficiency compared to traditional TIMS sources. Testing of a HECS source coupled to a Finnigan MAT 262 mass spectrometer at the IAEA Safeguards Analytical Laboratory in Austria reveals that significantly higher efficiencies can be achieved for the analysis of uranium and plutonium. Sample utilization efficiency (ratio of ions detected to atoms loaded) for picogram to nanogram loads are on the order of 5-25%. Performance is significantly improved over conventional TIMS analyses on the same sized loads. Utilizing Faraday cups to measure the major isotopes and the single SEM for a selected minor isotope, external precision of 0.08% and 0.15% was achieved for 20:1isotope ratios on 165 and 20pg loads, respectively, with bias less than 0.03%. In addition to data from HECS testing on the MAT262, efforts to adapt the HECS to a Triton TIMS will be discussed. These results suggest that the HECS source may offer a means of improving isotopic measurement for very small sample amounts.

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