

Synthesis of Ag:Er alloy for MMC (Metallic Magnetic Calorimeters) sensor material using induction heating method

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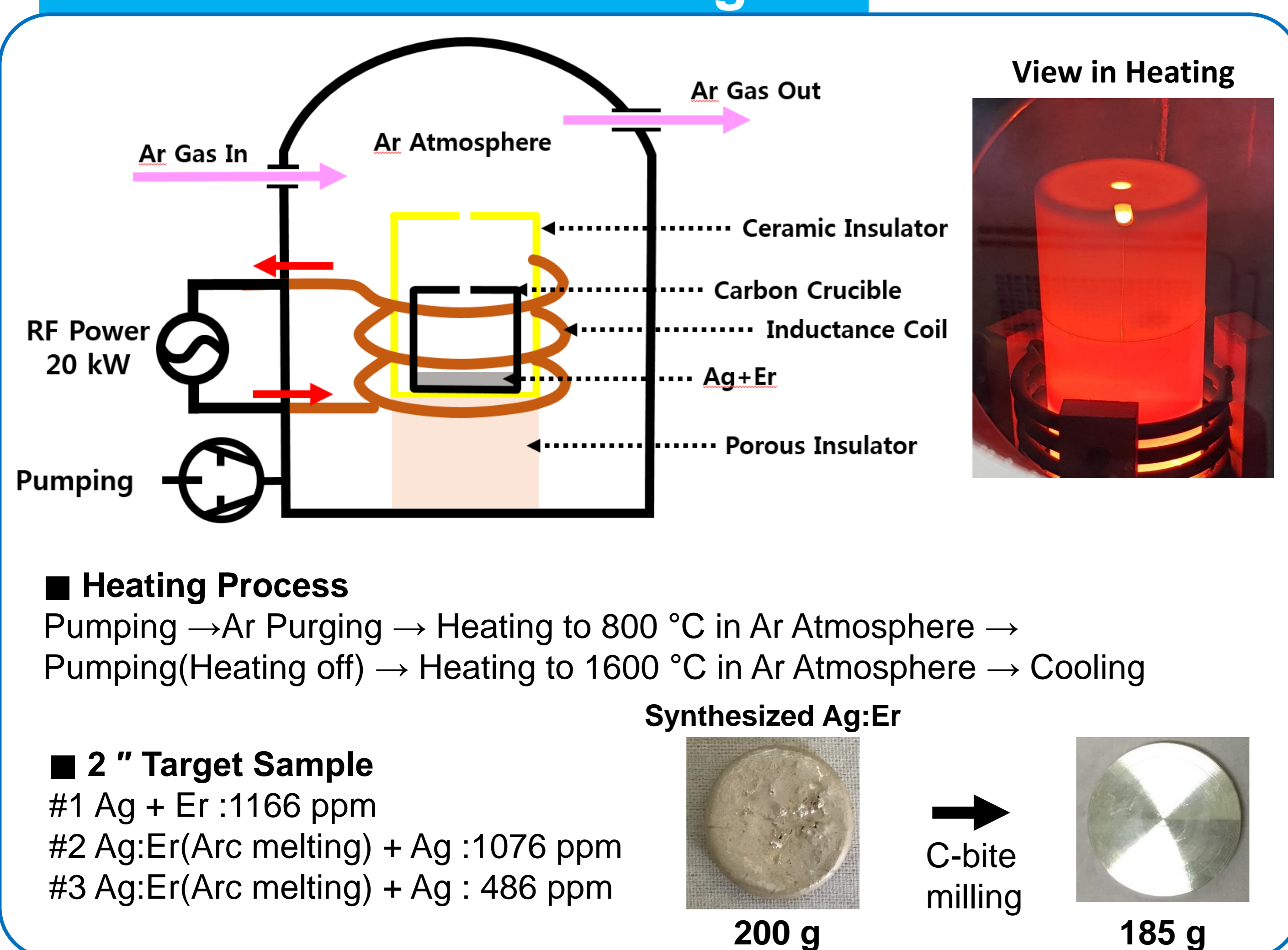
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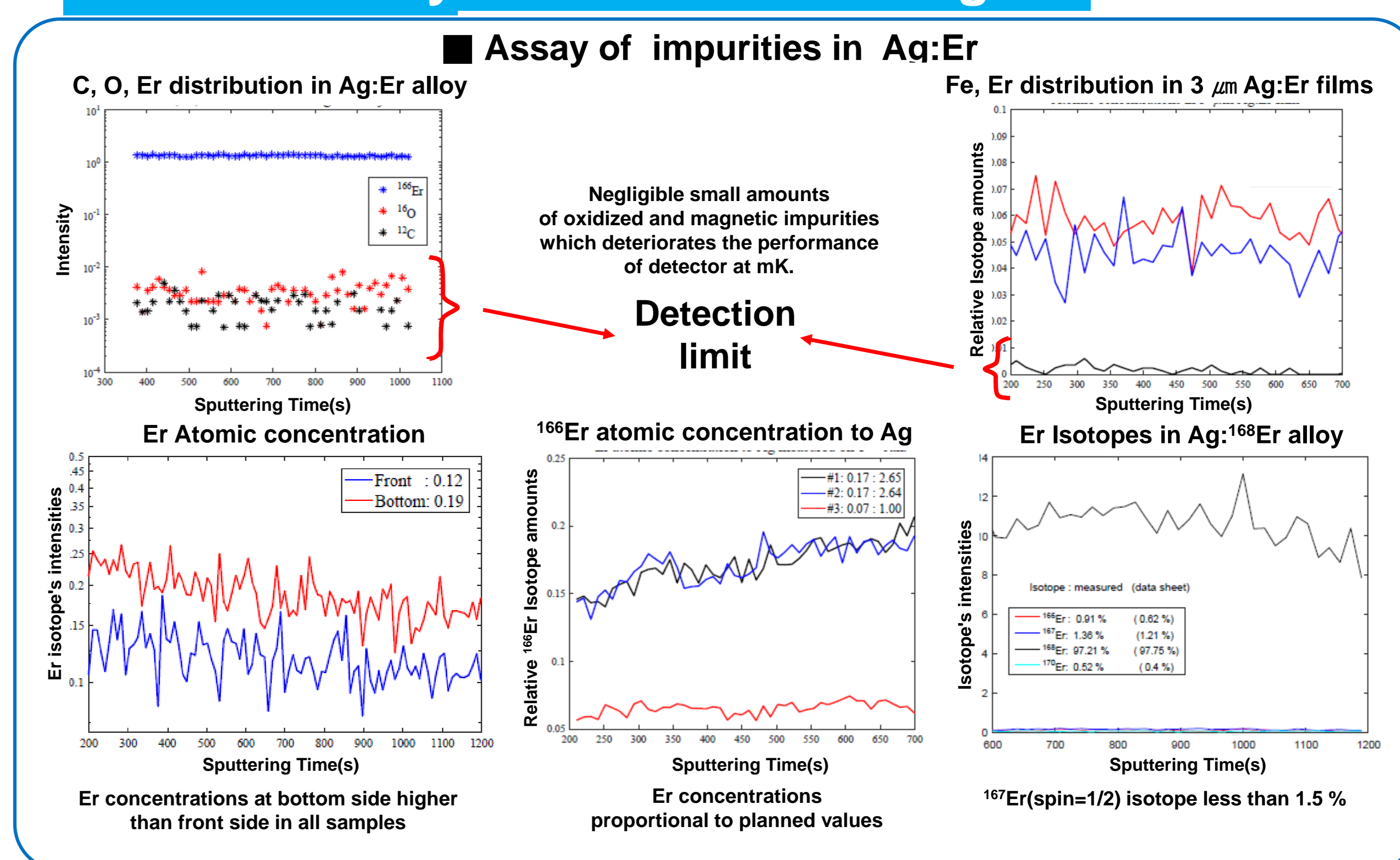
Abstract

Ag and Er in a carbon crucible with 2 " inner diameter was melt by induction heating. The chamber of the heating furnace was pumped into vacuum and maintained at Ar gas atmospheric pressure to suppress Ag evaporation. The internal temperature of the carbon crucible was raised to 1700°C even higher than Er melting point (1529°C) to form a convection flow in melt metals. Convection of the metal liquid allows Er atoms to be homogeneously mixed throughout the sample. The synthesized Ag:Er alloy was assayed by mass spectroscopy and magnetic property measurement. The mass spectra taken from Secondary Ion Mass Spectrometry(SIMS) showed that the amounts of oxygen and magnetic impurities such as iron are negligibly small, which does not deteriorate MMC performance in mK region. The temperature dependence of measured magnetization showed paramagnetic property of Ag:Er alloy, which applies to estimate Er concentration. Among the synthesized 2" alloy disks with 12 mm thickness, the Er concentration at the bottom was at least more than 20% higher than the surface, depending on the speed in cooling the heated carbon crucible. The Er atoms larger in mass than Ag are expected to be sedimented at the bottom of crucible during solidification of metal liquid. Ag:Er alloy liquid in the high temperature was rapidly cooled to make the Er atoms be uniformly distributed in 2 " Ag:Er sputtering target. A thin film with a thickness of 3 μm for MMC will be fabricated from the synthesized 2 " Ag:¹⁶⁸Er target.

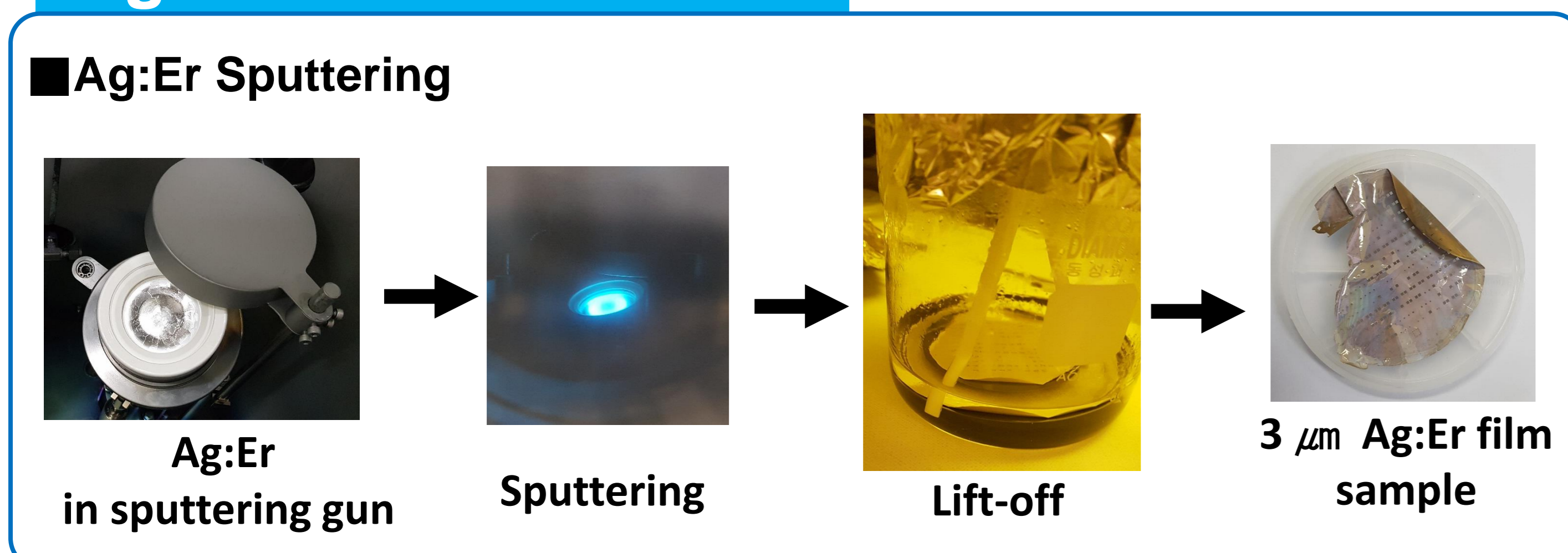
RF Induction Heating



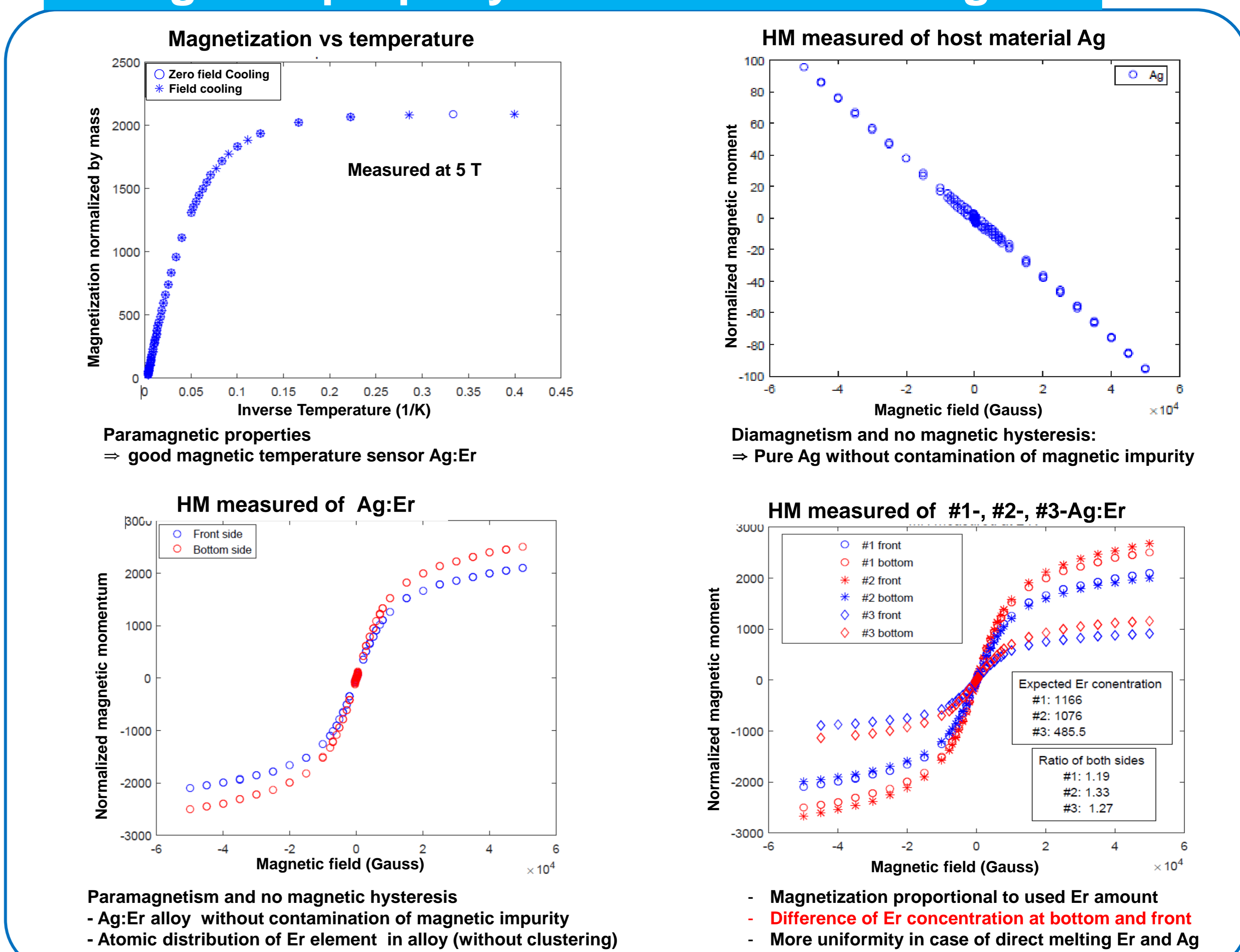
Element Analysis of elements in Ag:Er



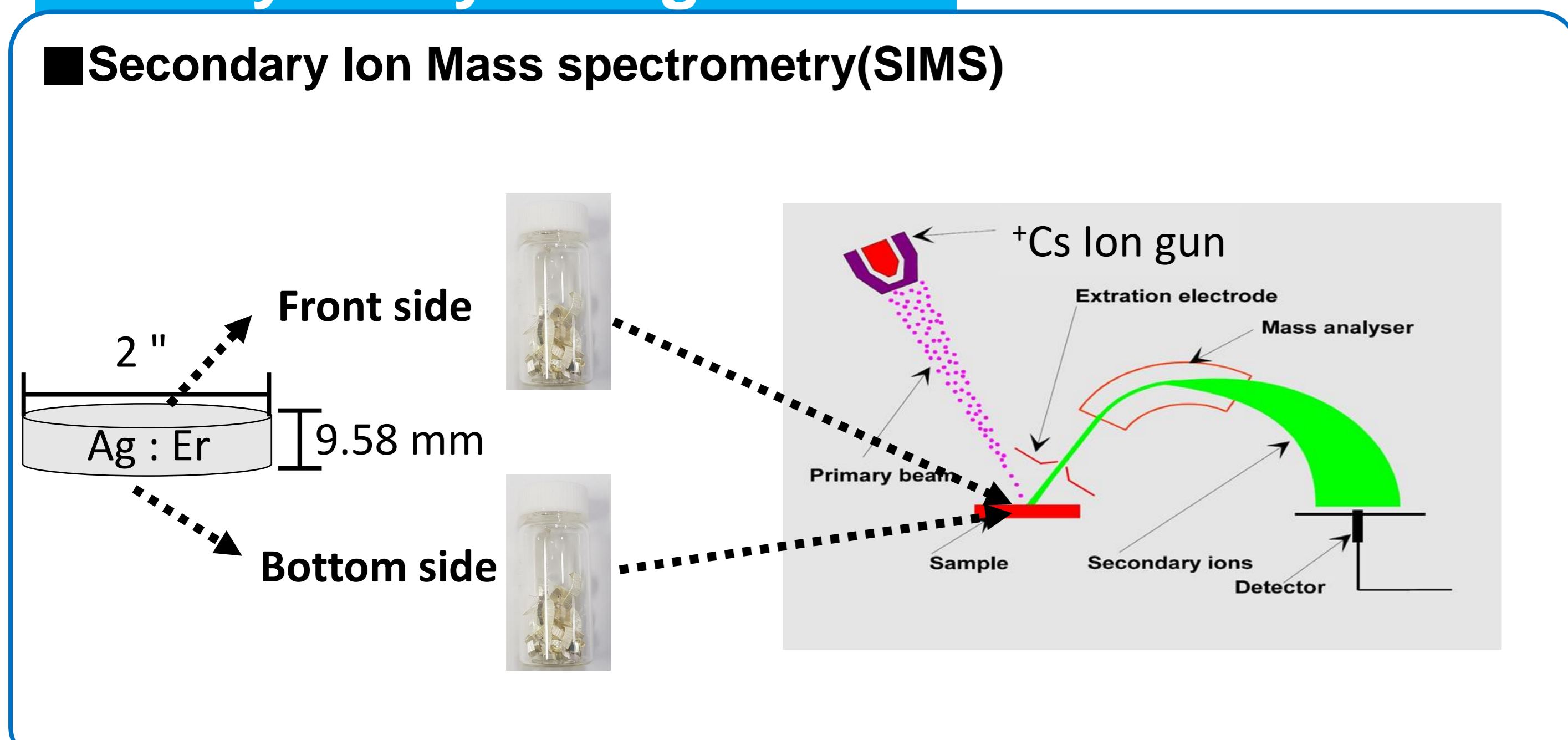
Ag:Er film fabrication



Magnetic property measurements in Ag:Er



Analysis by using SIMS



Conclusion & Future Plan

- ◆ 2 " Ag:Er alloy disks with 200 g mass were synthesized by inductively heating carbon crucible under Ar atmosphere.
- ◆ The data from elements assay and magnetic property of Ag:Er showed synthesized samples free from magnetic impurity elements and oxygen.
- ◆ Er elements in alloy are atomically distributed without clustering.
- ◆ The Er concentrations in front and bottom side of 2 " Ag:Er disks with 1 cm thickness differed up to 30 %.
- ◆ In order to obtain a uniform distribution of Er concentration in Ag:Er, methods of generating vigorous convection of hot Ag and Er metal liquid in carbon crucible are under study.