Due to its better superconducting properties (critical temperature \( T_c = 18.3 \) K, superheating field \( H_{c2} = 400 \) mT), Nb\(_3\)Sn is considered as a potential alternative to niobium (\( T_c = 9.25 \) K, \( H_{c2} = 200 \) mT) for superconducting radiofrequency (SRF) cavities for particle acceleration. Magnetron sputtering is an effective method to produce superconducting Nb\(_3\)Sn films. We deposited superconducting Nb\(_3\)Sn films on samples with magnetron sputtering using co-sputtering, sequential sputtering, and sputtering from a stoichiometric target. Nb\(_3\)Sn films produced by magnetron sputtering in our previous experiments achieved DC superconducting critical temperature up to 17.93 K and RF superconducting transition at 17.2 K. A magnetron sputtering system with two identical cylindrical cathodes that can be used to sputter Nb\(_3\)Sn films on cavities has been designed and is under development now. We report on the design and the current progress on the development of the system.

**Nb\(_3\)Sn fabrication processes and results**

**Process 1**
Sputtering was performed at a 3 mTorr Ar pressure with a constant DC current of 150 mA on a substrate heated up to 800 °C.

**Parameters optimized**
- DC power
- Substrate temperature
- Annealing temperature
- Annealing time

**Film properties:**
- Good \( T_c \)
- Nb\(_3\)Sn phase only
- Sn-rich clusters
- Sn deficiency on surface

**Process 2**
Multiple layers of Nb and Sn films with a thickness of 20 and 10 nm respectively. The multilayers were annealed at 950 °C for 3 h.

**Parameters optimized**
- DC power
- Substrate temperature
- Annealing temperature
- Annealing time

**Film properties:**
- Good \( T_c \)
- Nb\(_3\)Sn phase only
- Voids are observed
- Sn deficiency were found after annealing

**Process 3**
The powers of both targets were optimized to maintain the film stoichiometry and the cosputtered samples were further annealed.

**Parameters optimized**
- Nb\(_3\)Sn power ratio
- Substrate temperature
- Annealing temperature

**Film properties:**
- Good \( T_c \)
- Nb\(_3\)Sn phase only
- No voids
- Sn deficiency observed after annealing

**Cylindrical magnetron sputtering system**
A cylindrical magnetron sputtering system for deposition of a multilayer Nb and Sn layers, with its associated computer control unit has been designed and fabricated by PLASMIONIQUE Inc. The goal of our current research is to establish a multilayer sputtering system to deposit Nb\(_3\)Sn films inside a single cell RF cavity. The system will be optimized further to apply cosputtering and sputtering from a stoichiometric target.

**Conclusion**
A cylindrical magnetron sputtering system has been designed to fabricate Nb\(_3\)Sn films inside a 2.6 GHz cavity. The simulation and experimental results validated the design for SRF cavity coating. The fabrication procedure of the sputtering system has been initiated to commission the system for 2.6 GHz SRF cavity coating in 2021.

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