

11-14 November 2025
Opatija, Croatia



Contribution ID: 20

Type: poster

Update on Silicon Nitride Development by Radiofrequency Magnetron Sputtering for GW Mirror Coatings

The detection of gravitational waves (GWs) depends upon interferometers that use mirrors specifically designed to reduce both optical absorption and mechanical dissipation, thus meeting the high sensitivity demands necessary for detection. Advanced mirror coatings are made up of alternating thin layers of dielectrics such as tantalum oxide (Ta_2O_5), doped with TiO_2 , and silicon dioxide (SiO_2). Despite offering low optical absorption, the mechanical losses of these materials, tantalum oxide in particular, are substantial, posing a key challenge to attaining the needed sensitivity.

Silicon nitride (Si_3N_4) has recently gained interest as a replacement for $\text{Ti}:\text{Ta}_2\text{O}_5$ because of its considerably lower mechanical loss. However, its optical absorption remains too high for effective gravitational wave (GW) applications, and the reasons for this are not fully clarified. The method of deposition plays a crucial role in determining the physical and optical characteristics of thin films. This study explores radiofrequency magnetron sputtering (MS) as an approach for producing SiN films. While the Ion Beam Sputtering (IBS) technique is the technology of choice for producing GW mirrors, MS offers some advantages in terms of stoichiometry control and can help investigate the role of stoichiometry in determining the overall film absorption. The initial aim is to optimize the deposition process to achieve uniform film thickness over the substrate. Afterward, the goal is to produce stoichiometric Si_3N_4 that is expected to deliver peak performance, utilizing Rutherford Backscattering Spectroscopy (RBS) to assess its composition. The optical properties of these films were also analyzed through ellipsometry and photothermal deflection spectroscopy, focusing on the effects of oxygen incorporation on absorption and refractive index, as well as how annealing can reduce optical losses.

Authors: MARCHETTI, Simone; Dr MAGGIONI, Gianluigi (University of Padova - Department of Physics and Astronomy & Istituto Nazionale di Fisica Nucleare - Laboratori Nazionali di Legnaro); Dr SKLIAROVA, Hanna (University of Padova - Department of Physics and Astronomy & Istituto Nazionale di Fisica Nucleare - Sezione di Padova); Prof. MARTUCCI, Alessandro (University of Padova - Department of Industrial Engineering); Dr GRANATA, Massimo (Laboratoire des Matériaux Avancés—IP2I, CNRS, Université de Lyon, Université Claude Bernard Lyon 1); Dr FOREST, Danièle (Laboratoire des Matériaux Avancés—IP2I, CNRS, Université de Lyon, Université Claude Bernard Lyon 1); Dr BUSDON, Nicole (University of Padova - Department of Physics and Astronomy & Istituto Nazionale di Fisica Nucleare - Sezione di Padova); Dr MILOTTI, Valeria (University of Padova - Department of Physics and Astronomy & Istituto Nazionale di Fisica Nucleare - Sezione di Padova); Dr ZENDRI, Jean-Pierre (Istituto Nazionale di Fisica Nucleare - Sezione di Padova); Dr CONTI, Livia (Istituto Nazionale di Fisica Nucleare, Sezione di Padova); Prof. CAGNOLI, Gianpietro (University of Padova - Department of Physics and Astronomy & Istituto Nazionale di Fisica Nucleare - Sezione di Padova); Prof. BAZZAN, Marco (University of Padova - Department of Physics and Astronomy & Istituto Nazionale di Fisica Nucleare - Sezione di Padova)

Presenter: MARCHETTI, Simone

Session Classification: Poster Session

Track Classification: ISB: Optics