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Investigations on Caesium Dispersion and Molybdenum Coating on SPIDER Components

Valentina Candela [1,2,*,†], Caterina Cavallini [1,3,*,†], Claudia Gasparrini [3,4], Lidia Armelao [5,6], Valeria Candeloro [3], Mauro Dalla Palma [3,7], Michele Fadone [3], Diego Marcuzzi [3], Mauro Pavei [3], Adriano Pepato [2], Basile Pouradier Duteil [3,8], Marzio Rancan [9], Andrea Rizzolo [3], Emanuele Sartori [3,10], Beatrice Segalini [3], Gianluigi Serianni [3], Monica Spolaore [3], Federico Zorzi [11] and Piergiorgio Sonato [3,10]

1 Centro Ricerche Fusione, Università degli Studi di Padova, Corso Stati Uniti 4, 35127 Padova, Italy
2 Istituto Nazionale di Fisica Nucleare (INFN)—Sezione di Padova, Via Marzolo 8, 35131 Padova, Italy
3 Consorzio RFX, CNR, ENEA, INFN, Università di Padova, Acciaierie Venete SpA, Corso Stati Uniti 4, 35127 Padova, Italy
4 Department of Materials & Centre for Nuclear Engineering, Imperial College London, London SW7 2AZ, UK
5 Department of Chemical Sciences, University of Padova, Via F. Marzolo 1, 35131 Padova, Italy
6 Department of Chemical Sciences and Materials Technologies (DSCTM), National Research Council (CNR), Piazzale A. Moro 7, 00185 Roma, Italy
7 CNR—Istituto per la Scienza e Tecnologia dei Plasmi, 35127 Padova, Italy
8 Swiss Plasma Center (SPC), Ecole Polytechnique Fédérale de Lausanne (EPFL), CH-1015 Lausanne, Switzerland
9 Institute of Condensed Matter Chemistry and Technologies for Energy (ICMATE), National Research Council (CNR), via F. Marzolo 1, 35131 Padova, Italy
10 Dipartimento di Ingegneria Industriale, Università degli Studi di Padova, Via Gradenigo 6, 35131 Padova, Italy
11 Centro di Analisi e Servizi Per la Certificazione (CEASC), University of Padua, 35121 Padua, Italy
* Correspondence: valentina.candela@igi.cnr.it (V.C.); caterina.cavallini@igi.cnr.it (C.C.)
† These authors contributed equally to this work.

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Abstract: SPIDER is the 100 keV full-size Negative Ion Source prototype of the ITER Neutral Beam Injector, operating at Consorzio RFX in Padova, Italy. The largest Negative Ion Source in the world, SPIDER generates an RF driven plasma from which Deuterium or Hydrogen negative ions are produced and extracted. At the end of 2021, a scheduled long-term shutdown started to introduce major modifications and improvements aiming to solve issues and drawbacks identified during the first three years of SPIDER operations. The first action of the shutdown period was the disassembly and characterization of the SPIDER beam source after removal from the vacuum vessel and its placement inside the clean room. Each component was carefully assessed and catalogued, following a documented procedure. Some source components, i.e., the Plasma Grid, Extraction Grid and Bias Plate, revealed the presence of different and non-uniform red, white and green coatings that might be correlated to back-streaming positive ions impinging on grid surfaces, electrical discharges and caesium evaporation. Thus, several analyses have been carried out to understand the nature of such coatings, with the study still ongoing. The evidence of caesium evaporation and deposition on molybdenum-coated SPIDER components, such as the formation of oxides and hydroxides, is demonstrated through surface characterization analyses with the use of the Scanning Electron Microscope (SEM), X-ray Diffraction (XRD) and X-ray Photoelectron Spectroscopy (XPS).

Keywords: SPIDER; ITER; caesium evaporation; NBI; caesium deposits

1. Introduction

The Source for the Production of Ion of Deuterium Extracted from Rf plasma (SPIDER) is located in Padova, Italy, at Consorzio RFX. SPIDER is a full-size prototype of the radio frequency negative ion source for the International Thermonuclear Experimental Reactor (ITER) neutral beam injector (NBI) equipped with a 100 keV accelerator.