# (SG1) Multi-phase and Atomic/Molecular physics group report

May 14, 2024 (M. Kobayashi)

Date: May 10, 2024
Time: 10:30 -16:45
Shot#: 190927 – 191046 (120 shots)

Prior wall conditioning: No
Divertor pump: Off
Gas puff: H2, N2, Ne, Ar  IPD: No
LID: 3000A
NBI#(1, 2, 3, 4, 5)=gas(H, H, H, H, H)=P(4.4, 3.9, 4.4, 3.4, 4.1) MW
ECH(77GHz)=ant(5.5-U, 2-OUR)=P(698, 380)kW
ECH(154GHz)=ant(2-OLL, 2-OUL, 2O-LR)=P(705, 889, 982) kW
ECH(116GHz)=ant(2O-LR)=P(-)kW
ECH(56GHz)=ant(1.5-U)=P(-)kW
ICH(3.5U, 3.5L, 4.5U, 4.5L) = P(-, -, -, -) MW

Topics

1. Understanding of the evolution of cosmic organic dust in reaction with plasma (I. Sakon)
2. Electron temperature locking at edge magnetic island during detachment (M. Kobayashi)

# Understanding of the evolution of cosmic organic dust in reaction with plasma

20240510

(I. Sakon, T. Miyata, T. Onaka, K. Kobayashi, Y. Kebukawa, J. Takahashi, M. Tanaka, H. Nakamura, M. Shoji, S. Masuzaki, M. Kobayashi)

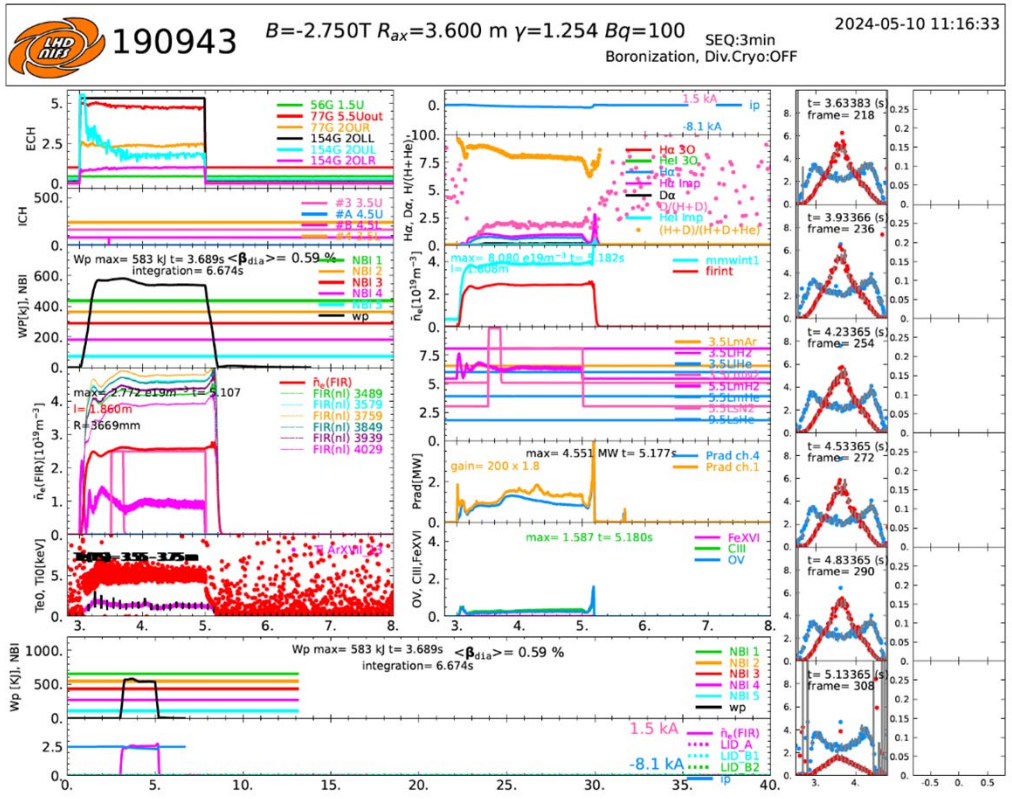
**Background & objectives:** In the previous run (Cycle 24 experiment), the experiment was conducted at the LHD of the NIFS, irradiating hydrocarbon dust with a relatively low-energy plasma (hydrogen and nitrogen) at the outer edge of the LHD plasma. Preliminary analysis revealed changes in infrared properties of filmy QCC that reproduce the characteristics of peculiar unidentified infrared bands observed in galaxies with weak active galactic nuclei (Smith et al. 2007) and in elliptical galaxies (Bregman et al. 2008; Kaneda et al. 2005), characterized by the absence of the 6-9μm bands corresponding to stretching modes of aromatic C-C bonds and the presence of only the 11-14μm bands corresponding to out-of-plane bending modes of aromatic C-H bonds. While the polycyclic aromatic hydrocarbons (PAHs) hypothesis is widely accepted in astronomy as the carrier of these bands, the exact understanding of their nature is incomplete. Thus, the identification of the carrier responsible for these bands and the determination of the physical factors giving rise to their characteristics remain unresolved for galaxies with weak active galactic nuclei and elliptical galaxies. Here we propose exposure experiment of hydrocarbon solids to the Large helical Device (LHD) plasma by means of a movable sample holder in the 10.5-L port and collect organic dust on the Si or SiO2 substrate.The present study aims to understand the properties of interstellar organic matter in space, based on an integrated approach involving astronomical observations, experimental astrophysics, and molecular dynamics simulations.

*Reference:[1] J. D. Bregman et al. 2008, ASP Conf. Ser. 381, 34, [2] I. Endo, I. Sakon, T. Onaka et al. 2021, ApJ, 917, 103, [3] H. Kaneda et al. 2005, ApJ, 632, 83, [4] J. D. T. Smith et al. 2007, ApJ, 656, 770*

**Results:**

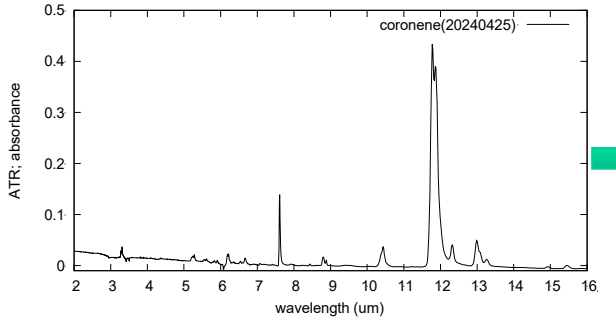
10mg of Coronene $C_{24}H_{12}$ on a SiO2 substrate (x1) and a few mg of filmy QCC on a Si substrate (x2) are exposed to the Hydrogen and nitrogen plasma (low-energy part of the LHD plasma). N2 are supplied at 3.5L port and 5.5L port. Experiment parameters of each shot are given in the following table. The probe to monitor the properties of plasma was attached to the sample holder and we confirmed that reaction with plasma flow of *** was achieved for each shot.

| Shot ID | N2 (5.5L) | N2 (3.5L) | H (5.5L) | comment |
|---|---|---|---|---|
| 190940 | 1500msec | 200msec | | -300mm |
| 190941 | 1500msec | 200msec | | -200mm |
| 190942 | 1500msec | 200msec | | -150mm |
| 190943 | 1500msec | 200msec | | -100mm |
| 190944 | 1500msec | 200msec | | -100mm, collapse |
| 190945 | None | None | | -100mm |



# *Experiment on LHD (cycle 25) at National Institute for Fusion Science*

C24H12 on SiO2 substrate

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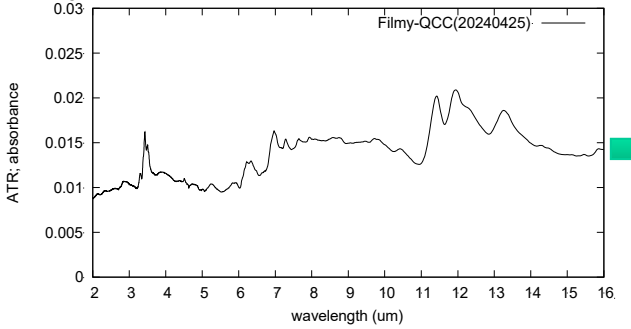
Filmy QCC #1 on substrate

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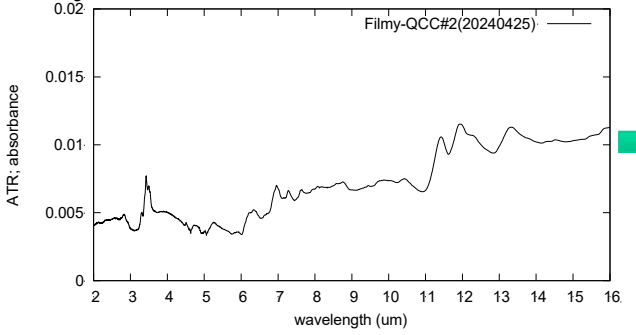
Filmy QCC #2 on substrate

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# Electron temperature locking at edge magnetic island during detachment

M. Kobayashi, 20240510

**Motivation & Objectives:**
It has been observed that the electron temperature at the island is “fixed” (Te locking) to a constant value during Neon seeding experiments while the radiated power increases according to the impurity seeding amount. In the present experiments, Ar seeding was conducted to investigate the impact of different cooling function on the Te locking.

**Results:**
$R_{ax}$ = 3.85m, B=2.57T, CCW, γ=1.254, Bq=100%. ECH ~ 3MW.

Ar seeding: Te at the island is fixed to ~140eV during Ar seeding scan, while radiated power increases. More than 32 ms Ar pulse led to radiative collapse.

Ne seeding: Te is fixed to ~140eV or ~30eVduring Ne seeding scan. Te changes stepwise and no intermediate values are possible. This suggests that the system is bistable. After the transition to lower Te (30eV) the radiation is almost doubled.

To sustain Ar seeding plasma, more power is needed.
Prad estimate:
~ 3 MW with Ne at 30eV,
~13 MW with Ar at 10eV,
which is beyond ECH power.

VUV spectra were measured.