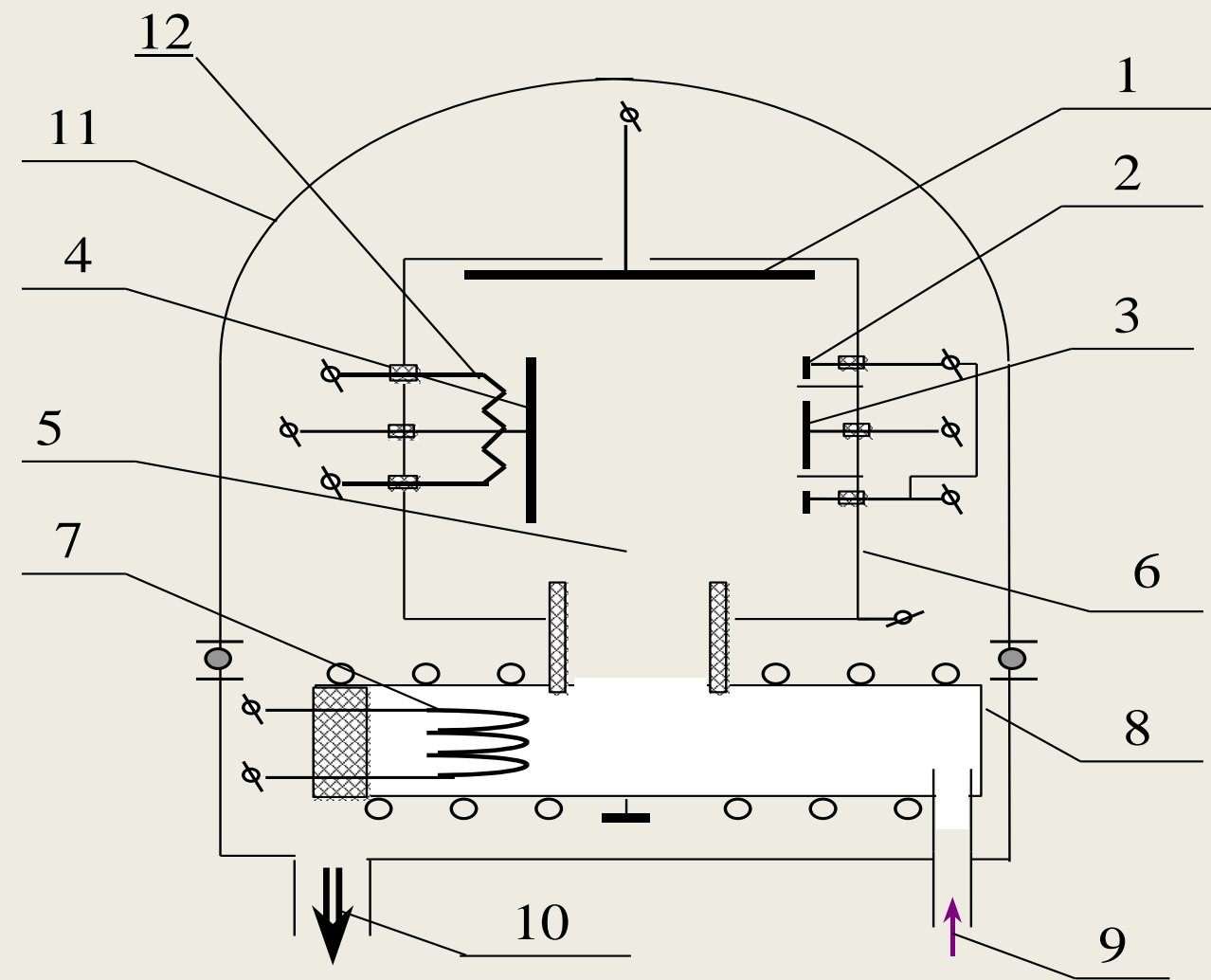


The Structure and Gas Trapping Properties of Plasma Deposited Carbon and Carbon-Tungsten Films

L. Begrambekov, A. Kuzmin, A. Makarov, Ya. Sadovsky, P. Shigin,

National Research Nuclear University, 115409, Moscow, Russia

Scheme of film deposition device



- 1 Anode,
- 2, 3 Sputtered W and C targets,
- 4 Substrate,
- 5 Space of gas discharge,
- 6 Plasma chamber,
- 7 Cathode,
- 8 Cathode chamber,
- 9 Gas inlet,

10 Pumping, 11 Vacuum chamber, 12 Substrate heater

Experimental

Residual gas pressure : $P = 4 \cdot 10^{-4}$ Pa

Working gas pressures: Argon ($P_{Ar} = 0.1$ Pa)
deuterium (P_D varied from $2.7 \cdot 10^{-4}$ to $1.3 \cdot 10^{-2}$ Pa.)

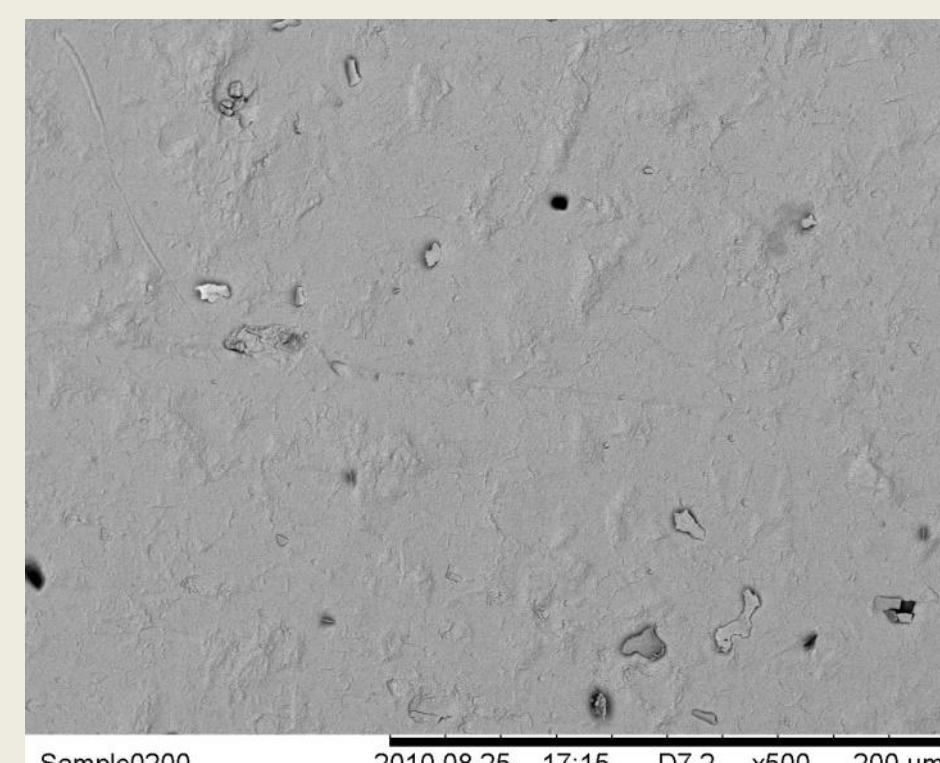
Substrates : fine grain graphite (C), stainless steel (SS) and tungsten (W) temperature 350°C

Substrate potential: Floating potential 6-8 eV

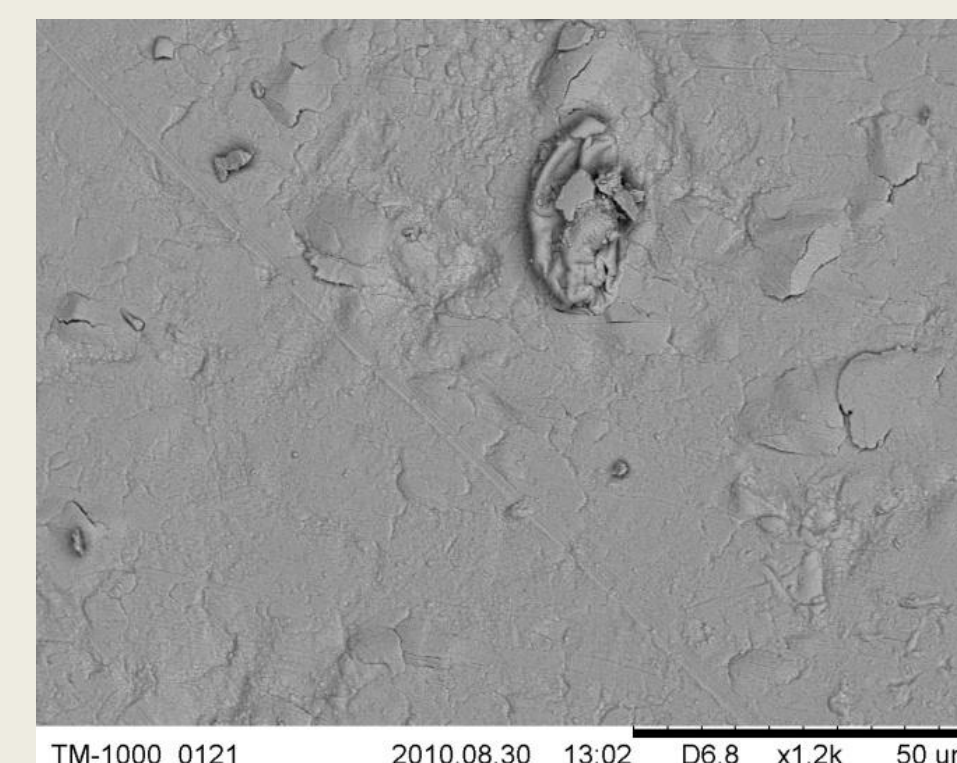
Rate of C and W atoms deposition: $1.1 \cdot 10^{19}$ and $2.8 \cdot 10^{19}$ at/m²s

The average C/W ratio in C-W films : ≈ 2.5

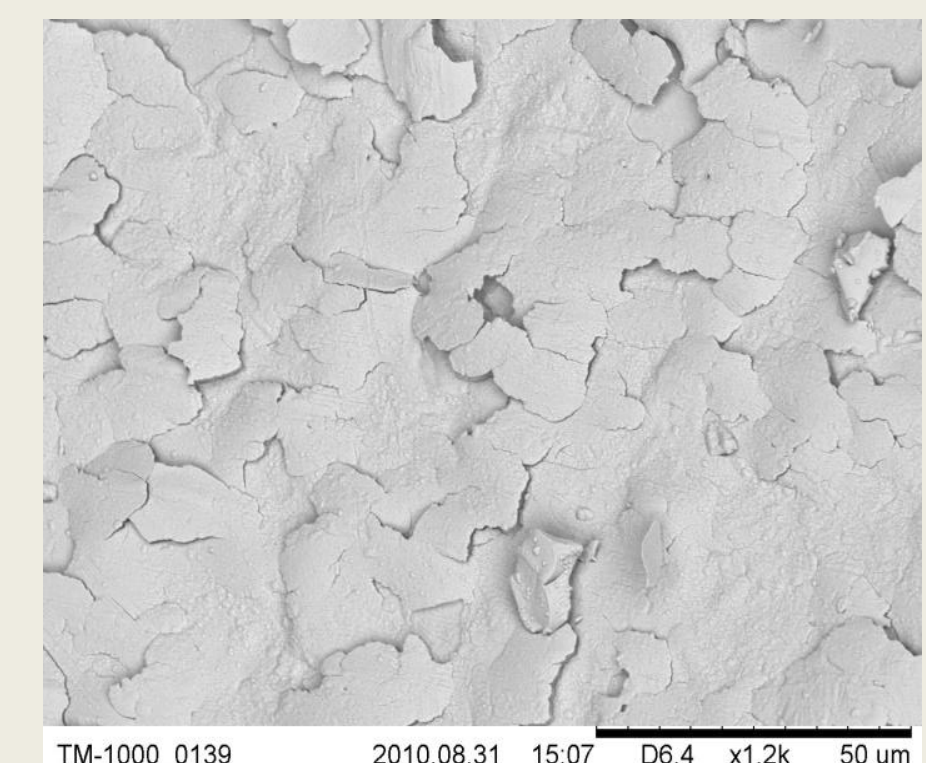
SS substrate. The films started cracking, and exfoliation began when their thickness reached $0.75 \mu\text{m}$.



SS thickness $0.40 \mu\text{m}$.



$0.40 \mu\text{m}$



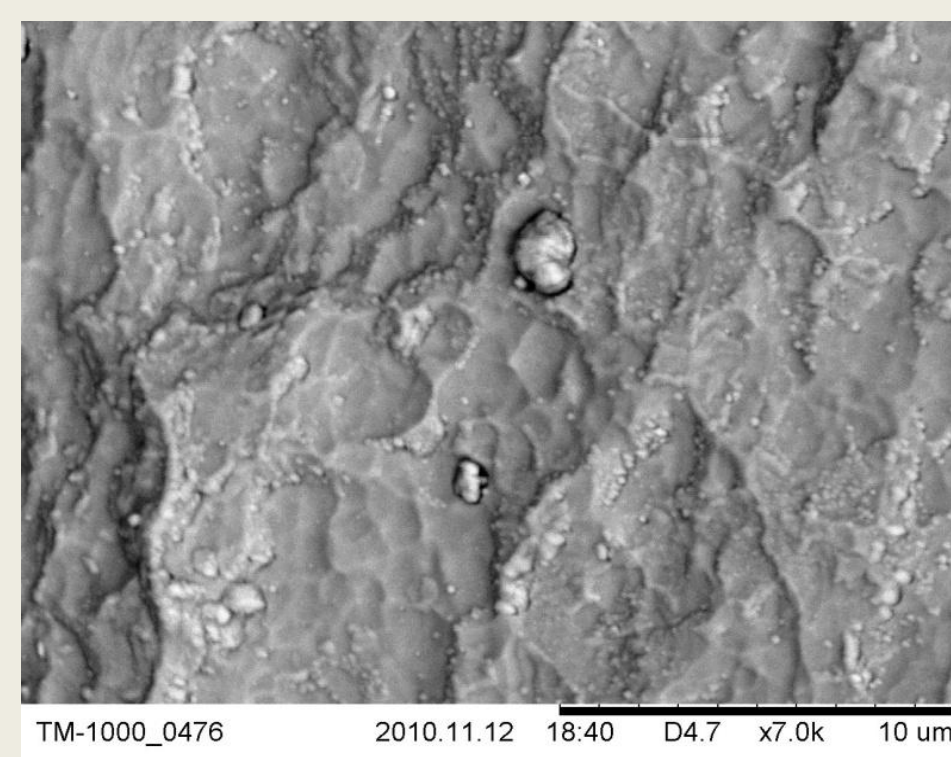
$0.75 \mu\text{m}$

W- and C substrates.

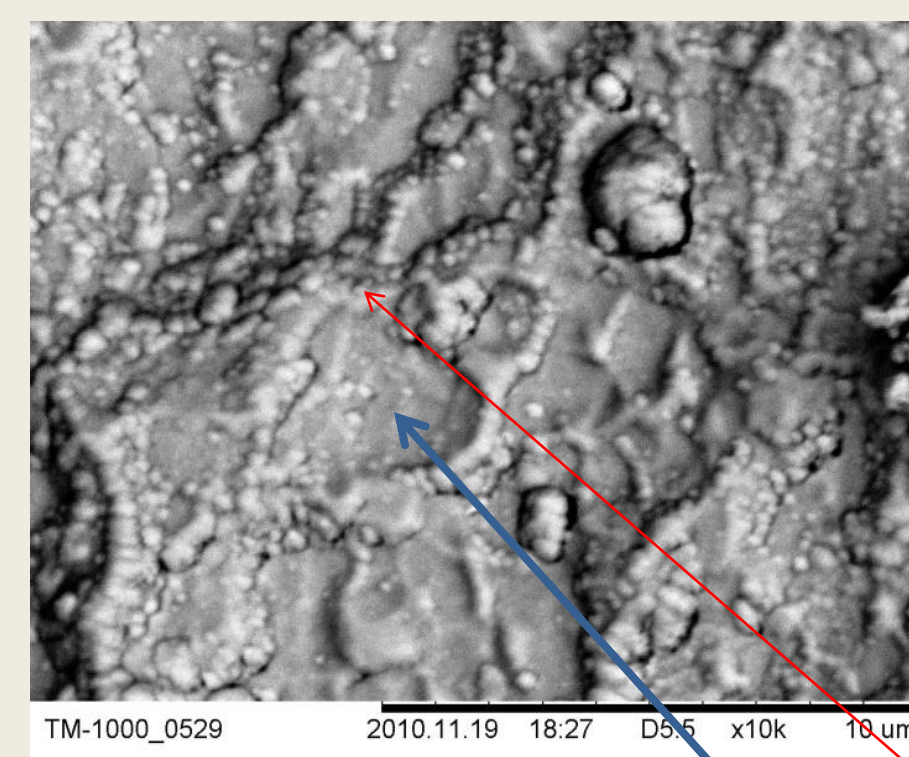
$0.5\text{-}0.7 \mu\text{m}$ -thick films have columnar structure. The upper carved layers of "big" columns (cross section $\approx 3 \mu\text{m}$) form flopping hills on the film surface. "Small" columns (c. s. $\approx 0.5 \mu\text{m}$) grow mainly around big columns. C/W ratio in the big columns was higher than that in the small ones. $W_b/W_s \approx 1.4$.

The fragments of $1 \mu\text{m}$ -thick films lose contact with C-substrate, but even $2.5 \mu\text{m}$ -thick films do not show massive exfoliation.

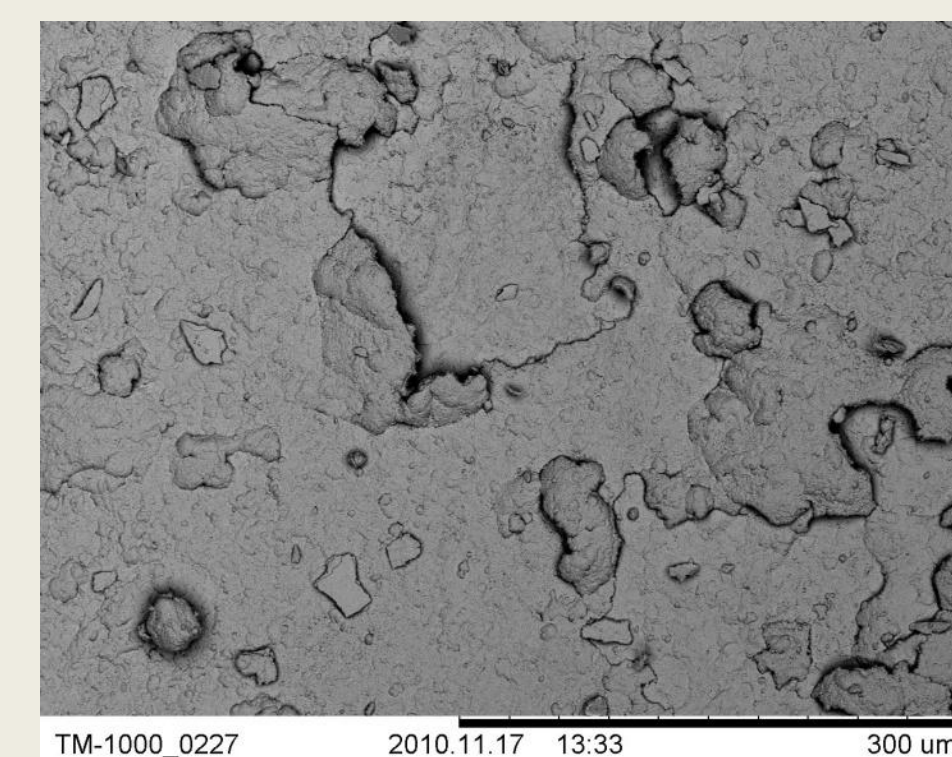
$2 \mu\text{m}$ -thick films on W-substrate are intensively destructed.



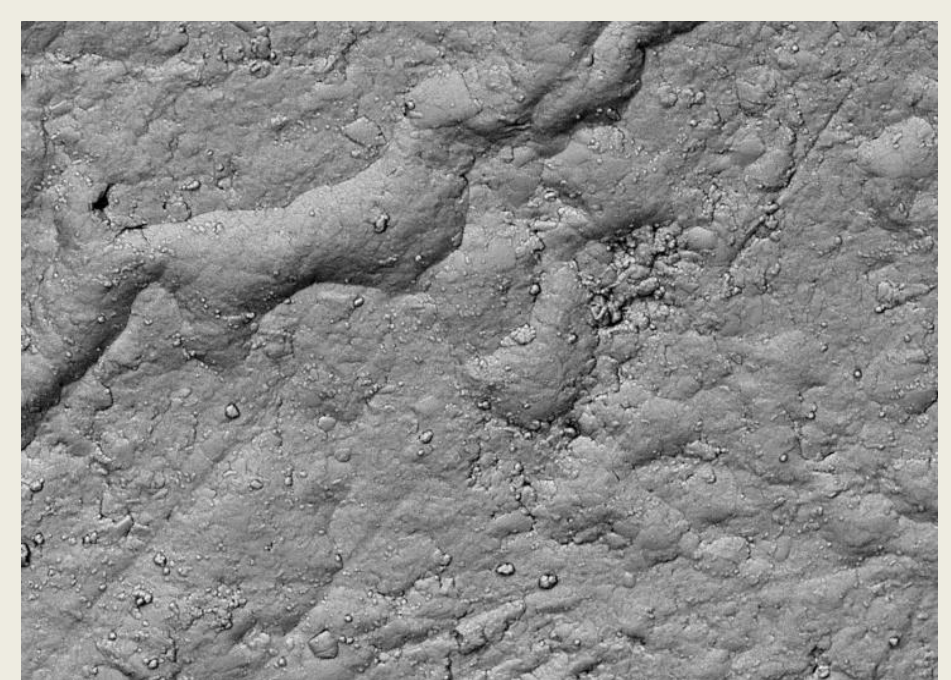
W. thickness $0.36 \mu\text{m}$.



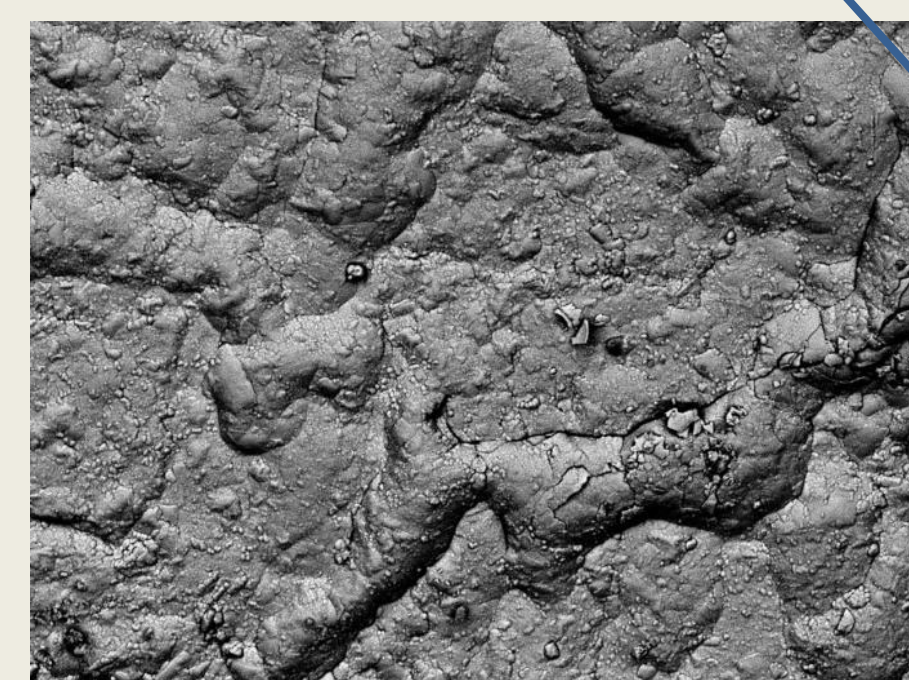
$0.72 \mu\text{m}$



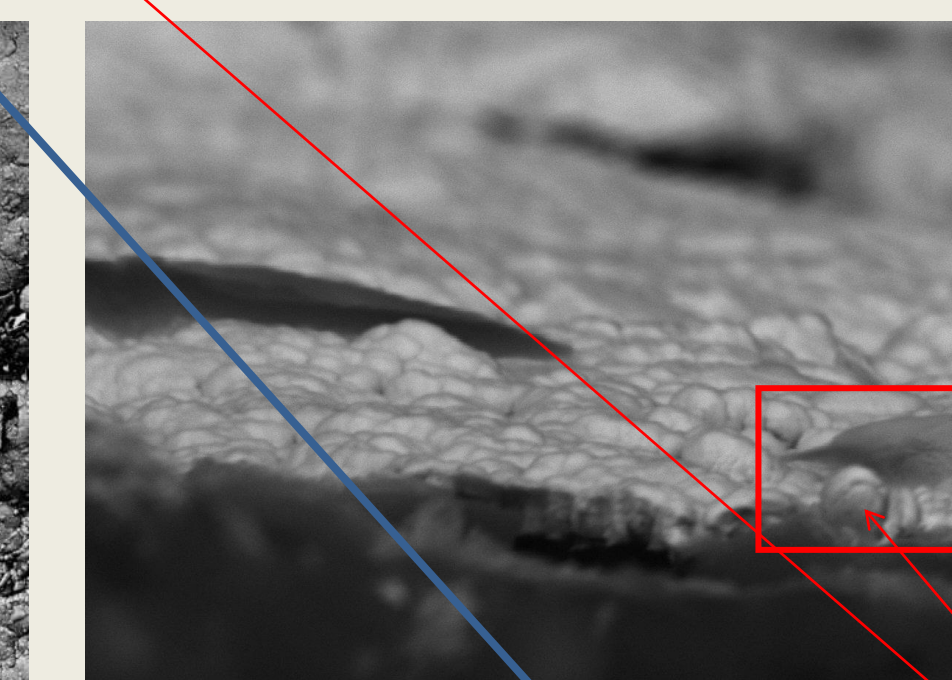
$2.50 \mu\text{m}$



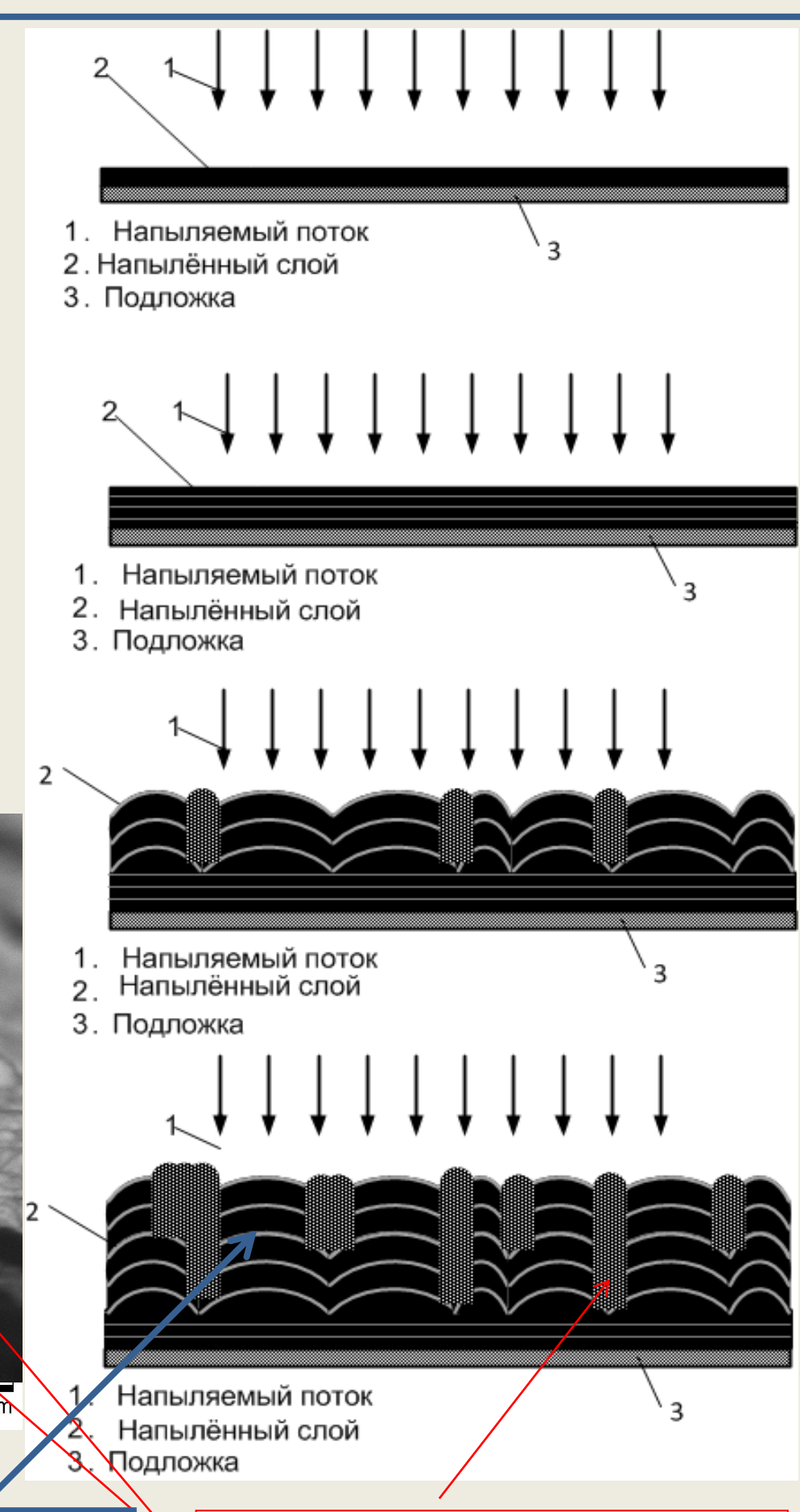
C. thickness $0.60 \mu\text{m}$.



$0.96 \mu\text{m}$



$0.96 \mu\text{m}$

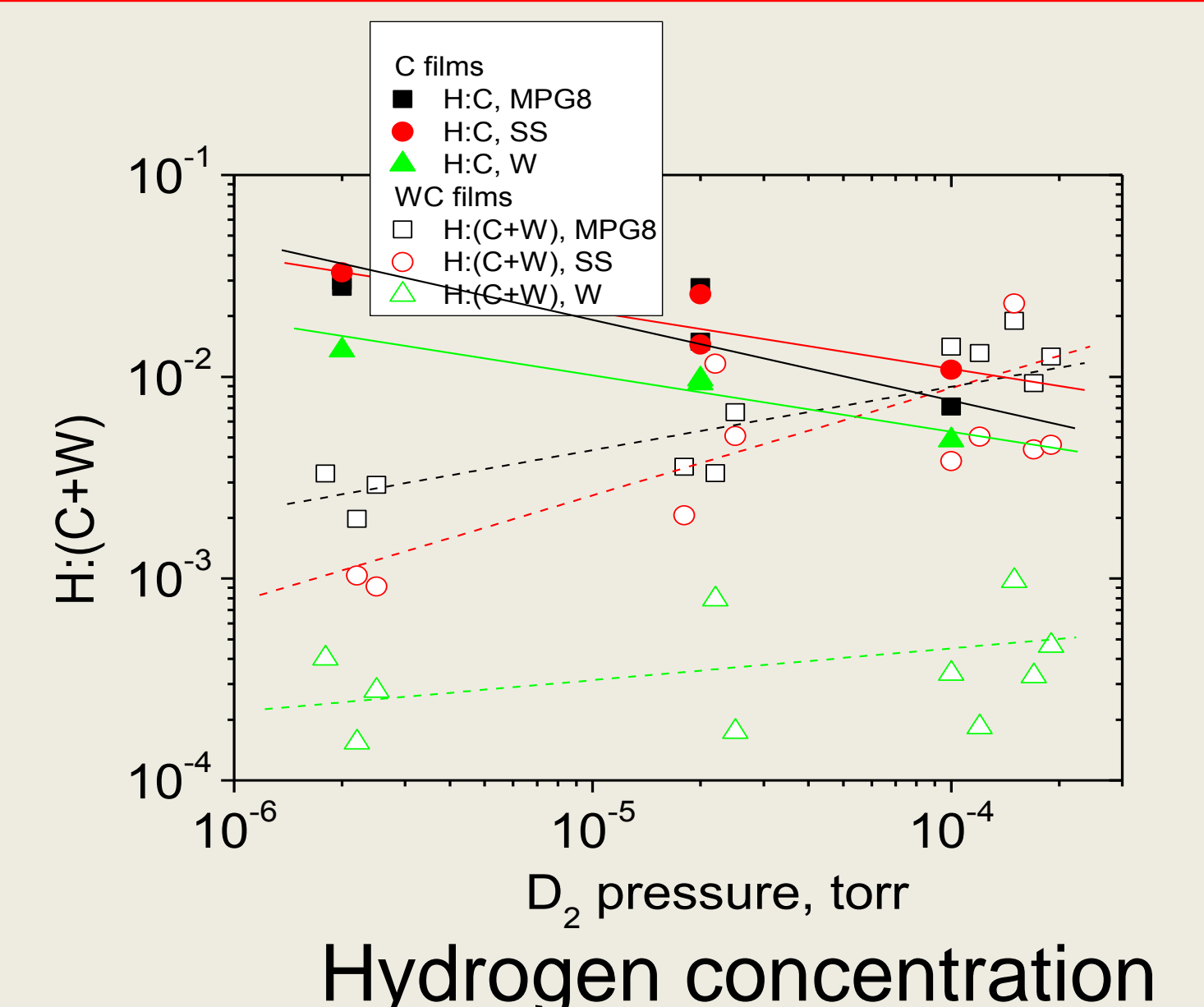
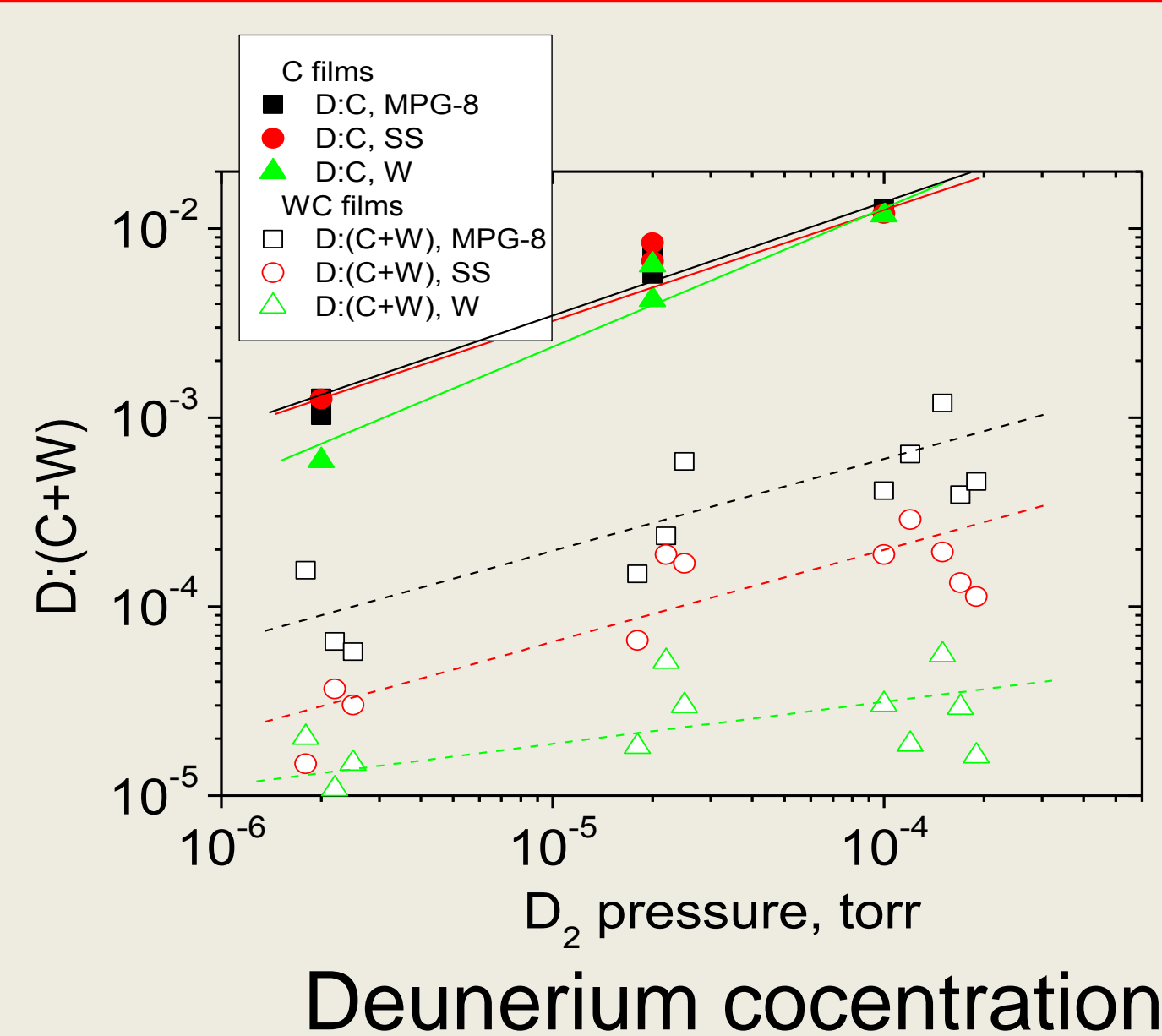


"Big" columns

"Small" columns

C films. D- and H concentrations (D/C and H/C) in the C films do not depend remarkably on the type of substrate. D/C increases and H/C decreases when P_D grows.

C-W films. H/C is higher than D/C, but contrary to C films both ratios increase along with P_D . D/C ratio of C-W films are some times smaller than D/C of C films and decreased from C- to W substrate.



Conclusion. Adhesion of C-W coating is higher on the graphite and tungsten substrates. The coating on C- and W substrates are consisted of the columns of two different types. The big columns is seen to be formed from the layers parallel to the surface. They have higher tungsten concentration, than the small ones appearing mainly along their borders. The columns of both types have or tend to have the tungsten carbide structure

The water molecules of residual gas sorbed on the surface of depositing films are the main source of hydrogen isotopes for trapping in the deposited films.