

# The Use of Ga and Li as Limiter Materials in T-3M and T-11M Tokamaks

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The limiter and divertor plates are most critical tokamak plasma facing components (PFC) with highest heat load. This load has character of short periodical pulses with melting and evaporation of PFC during plasma disruptions and Edge Local Mode development. As a best candidate materials for PFC should be a liquid metals (LM), which admit a permanent PFC renovation. This advantage of LM is known since from UWMAK-Project (1974), but the practical use of liquid metals has some potential obstacles in real tokamaks. In particular:

- a liquid metal splashing under MHD-forces in plasma instabilities,
- a probably abnormal liquid metal erosion, as result of: ion sputtering, unipolar arcs and instabilities of liquid metal –plasma boundary,
- a technological problems of liquid metal injection in strong magnetic fields.

The attempts to overcome this obstacles were undertaken in Russian T-3M and T-11M tokamaks ( $I_p \leq 100\text{kA}$   $B_T \approx 1\text{T}$ ) on 1990-2004 Years.

In T-3M droplet stream and film flow Ga limiters were tested. In T-11M were performed the experiments with Li Capillary Pore Systems (CPS) as rail limiter for modeling of real Li erosion in typical tokamak boundary condition ( $T_e = 30 \pm 10 \text{ eV}$ ,  $P_{\text{load}} = 10 \text{ MW/m}^2$ , D, He plasma).

The main results are:

1. The Ga-droplet stream can be useful as method of LM injection in tokamak. The Ga-film limiter experiment was unsuccessful.
2. The Li-CPS limiter experiment in T-11M was successful. It was received the quasi state (0.2s) clean deuterium plasma with  $Z_{\text{eff}} = 1.1 \pm 0.1$  ( $T_e(0) = 0.4\text{keV}$ ) and plasma boundary cooling by Li-radiation.
3. The Li emission from CPS-limiter increases with limiter temperature, but without any spontaneous peaks (Li-blooms, unipolar arcs e.a.) up to  $700^\circ\text{C}$ .
4.  $\text{D}_2$  removal from Li limiter can be made on simple heating up to  $400^\circ\text{C}$ .

This means, that use of a liquid metal as material of tokamak limiter has no serious physical obstacles.