FusionEPTalks

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Title: Advanced materials and new concepts for future fusion devices

Speaker: Andrey Litnovsky

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Abstract: The construction of the fusion power station, such as DEMOnstration power plant (DEMO) represents an ultimate scientific, engineering and safety challenge. In particular, materials facing fusion plasmas will have to withstand simultaneous neutron and plasma exposures and heat loads in the course of several hours of operation during a single plasma discharge of the power plant. These conditions will challenge material properties severely. It is clear already now, that conventional plasma-facing materials used in present-day fusion devices as well as in future fusion experiments, may not fully satisfy the requirements of a safe and reliable operation. The lecture will provide a “glimpse” into the creation of advanced materials for fusion. Based on a vast material science knowledge supported by new manufacturing technologies, it was possible to overcome several crucial natural limitations of conventional materials, such as tungsten both in terms of plasma performance as well as of their safety. The advanced tungsten-fiber-reinforced tungsten composites as well as micro-structured tungsten materials are being developed for a quasi steady-state operation under heat loads reaching 20 MW/m2 in the divertor of the power plant. The micro-structured tungsten demonstrated the unbelievable resilience and no detectable damage after the transient heat loads of up to 0.64 GW/m2 for 200.000 cycles. The innovative self-passivating SMART alloys ensure an acceptable plasma performance of the first wall of DEMO while maintaining the unprecedented 105-fold suppression of natural tungsten oxidation and more than 40-fold suppression of sublimation of tungsten oxide in case of an accident at the fusion power plant. The spectacular tungsten laminates feature the material ductility already at room temperature. These and other remarkable material concepts will be reviewed along with advanced manufacture techniques, such as additive manufacturing and field-assisted sintering technology. These technologies are used for scaling up the advanced materials to the reactor-relevant sizes thus making a crucial step toward the final goal – building of first wall and divertor components of the fusion power plant.

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