PEEK-INSULATED CONDUCTORS OF FAST IN-VESSEL SADDLE COILS FOR ASDEX UPGRADE

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Non-axisymmetric error fields in tokamaks can be employed to control MHD instabilities. In particular, a fast rotating error field can be used to avoid locking of magnetic islands to the wall structures and therefore delay a pending disruption. As an enhancement of the ASDEX Upgrade experiment, a set of 24 in-vessel saddle coils is being installed [1]. This coil set consists of three poloidally separated groups on the low field side. Upper and lower toroidal rings of eight coils [2] consist of five-turn copper windings, hermetically encapsulated in a welded inconel casing and insulated by glass fibre bedding and cast epoxy. Mounted close to passive conducting structures, these coils have a bandwidth up to 1 kHz [3] and are used for static fields and resistive wall mode feedback control. The larger bandwidth for the mid-plane coils (up to 3 kHz) requires avoidance of eddy currents in surrounding conducting structures which effectively shield the produced magnetic field and introduce inductive heating at high frequencies. Therefore, the middle ring of coils uses a different design: 1. The winding is supported by insulating spacers on a distant steel frame [4], and 2. the conductors are encapsulated by an insulated coating that is compatible with vacuum requirements and plasma operation without an additional metallic hermetic seal.

As a promising material, Polyetheretherketon (PEEK) has been qualified for this application. Exposure of PEEK samples to plasma conditions during two ASDEX Upgrade experimental campaigns shows that surfaces with direct sightline to the plasma show merely superficial decomposition due to UV irradiation. Unirradiated material mounted behind protecting plasma facing components remains perfectly intact. Spectroscopically, no additional impurity influx from the PEEK samples is detected during plasma operation. We investigate insulating PEEK coatings on copper conductors produced by two different methods: 1. Extrusion of PEEK around the raw copper wire before winding the coils. Applying this method, it is possible to produce a homogenous insulation layer with high elongation properties. 2. Spraying of PEEK-powder onto the heated wound conductor which is held at homogeneous high temperatures. This process is necessary for coatings on irregular profiles. Voltage standoff has successfully been tested up to 5 kV for all samples. The coated layers partly show bubbles at the conductor-insulator interface, however with no apparent impact on mechanic or dielectric properties. With respect to the torsional stress generated by the active conductors a stiff construction for the electrical feedthrough is presented. The ultra-high-vacuum compatibility is provided by a brazed CF-flange in combination with a PEEK-gasket. The feedthrough conductors are connected with the coil via two soldered joints, which can be realized inside the vessel.

[1] W. Suttrop et al., Fusion Eng. Des. **84** (2009) 290
[2] T. Vierle et al., Fusion Eng. Des. **84** (2009) 1928
[3] M. Rott et al., Fusion Eng. Des. **84** (2009) 1653
[4] I. Zammuto, this conference