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RF hollow feeder for ITER diagnostic mirrors cleaning system: breakdown risk assessment

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Ion sputtering in RF discharge is a primary candidate approach to periodic mirror recovery in ITER. Such discharge requires RF power of ~1 kW@10...100 MHz. The current approach to RF power transmission inside ITER vacuum vessel is mineral insulated cables. However, they are not acceptable as a full-fledged solution due to high insertion loss: up to 15% per meter. Rigid hollow feeder is considered as a solution alternative to the MI cables. Such feeder type has low insertion loss, but its power handling capability is limited by electrical breakdown. The conditions affecting the hollow feeder breakdown threshold in ITER are: pressure of 1...20 Pa in Ne, D2, He, etc. and their mixtures, magnetic field of 0.1...5 T, DC-biased line conductors, complex 3D structure incorporating conductive and dielectric materials, exciting wave electromagnetic field configuration, background temperature and ionizing radiation. Breakdown simulation in hollow feeder described, aiming to reveal breakdown-free parameters area. The available software tools allow breakdown simulation not for all ITER-specific conditions, and its experimental study is quite challenging and time consuming. Thus, to assess the risk of hollow feeder breakdown in ITER conditions, a software tool is being developed, based on direct Monte Carlo electron cloud evolution simulation. The main breakdown mechanism considered in conditions of interest is an avalanche-like electron density increase, which can occur due to either volumetric gas ionization or to so-called “multipactor” effect governed by secondary electron emission. The report discusses physical statement, mathematical approach, ways of the code validation, and preliminary simulation results.

Keywords
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