EXPERIMENTAL STUDY ON NOISES AND DC-RF EFFICIENCY OF MAGNETRONS FOR MICROWAVE POWER TRANSMISSION

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ABSTRACT

Microwave Power Transmission (MPT) technology is one of the most essential parts for Solar Power Station/Satellite (SPS). We study on the application of magnetrons as DC-RF transmitters for the MPT transmitting system including SPS. Magnetrons cost much lower and have much higher DC-RF efficiency over 70% and much higher output power than semi-conductors although they have a lot of spurious noises. The objectives of this study are the experimental research of the improvement of spurious noises generated from magnetrons and the increase of DC-RF efficiency of magnetrons.

We experimented with microwave-oven magnetrons, the frequency of which is 2.455GHz belonging to the ISM band.

First, we verified that the oscillation of magnetrons was maintained on DC power supply after turning off the filament current which provides thermal electrons in the magnetron tube. This continuous oscillation is given by the increase of back bombarding electrons striking and heating cathode. Next, we found that the free-running frequency spectrum of magnetrons improved narrower and most of spurious noise levels of them became lower on DC power supply after turning off the filament current (Figure 1). One reason of these improvements are the smoothing of anode current of magnetrons. When filament current was turned on while oscillating, we observed the fluctuation of the anode current owing to the constant voltage characteristics of the anode current – anode voltage performance of magnetrons. When it was turned off, we observed the smoothing anode current caused by the disappearance of the fluctuation of the anode current. Another reason is the reduction of thermal effects. When turning off the filament current, the cathode temperature became colder than when turning it on. That makes thermal effect in the magnetron tube lessen. Concering the DC-RF efficiency, we found about 3% falloff of the DC-RF efficiency after cutting off the filament current less than before, because of increasing both the output loss and the anode voltage to keep magnetrons oscillating.

Now we are researching sources of spurious noises by observing low frequency noises from 100kHz to 1GHz, which may modulate the main oscillation of magnetrons. We are also researching the way to reduce harmonics and spurious noises, which will interfere with other communication satellites and systems when SPS is assumed.

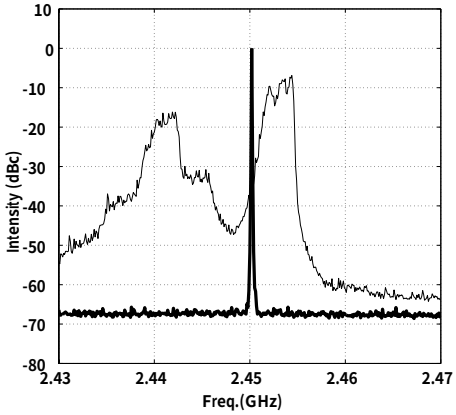

Figure 1: Free-running frequency spectra (anode current: 250mA, filament current: 10A (thin line), filament current: 0A (thick line), resolution bandwidth: 10kHz)