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Microwave plasma technologies for semiconductor processing

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'Large area', 'high uniformity', 'low temperature' and 'high density' are the most important issues in the development of plasma sources for semiconductor manufacturing processes. Various types of plasma sources are being developed to resolve the issues using electrical powers with frequency range from direct current to microwave. Their discharge properties and structural configurations depend strongly on the kind of electrical power sources.

Microwave plasma have attracted special attentions for processing semiconductor materials due to their advanced discharge properties since a microwave plasma was first applied to deposit diamond films in 1982 [1].

Microwave plasmas are produced by using an electromagnetic energy source with a high frequency (typically 2.45 GHz). In microwave plasmas, electrons are oscillated in response to the applied electromagnetic field, while ions are relatively stationary. This property allows a low temperature plasma with high density reactive radicals over a wide range of gas pressures.

However, in conventional microwave plasma sources, there are the limitation in the enlargement of plasma because of the short wavelength of microwave (12.2 cm for 2.45 GHz in free space) and the limitation in the increase of plasma densities because of the cut-off density (7.4 x 10^{10} cm^{-3} for 2.45 GHz). The limitations have caused delays in the application of microwave plasma sources to semiconductor processing compared to RF plasma sources.

Recently, advanced microwave plasma technologies including surface wave plasmas and microstrip line type plasmas have been developed to overcome the limitations [2-13].

In this talk, the fundamental discharge properties and the recent topics of microwave plasmas are reviewed and the potential of microwave plasmas for semiconductor processing are demonstrated.

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