Design of a Waveguide Slots Array Antenna for Uniform Heating of Material in a Cavity

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Abstract— Volatile organic compounds (VOCs), such as toluene and xylene, are generated inevitably during the processes of semiconductor fabrication, liquid crystal display (LCD) production, oil refining, etc. It must be removed since it is carcinogenic. Usually, it can be captured by a VOC filter and desorbed from the filter by thermal heating by the characteristic of volatility to recycle the filter. To achieve uniform heating inside the cavity, there are some methods of using multiple sources, or a mode stirrer or, rotary table to physically rotate the object to be heated. In this paper, a waveguide slots array (WSA) is designed using 8 tilted slots to improve the uniformity of the power loss distribution applied to the VOC filter inside the cavity structure. The element spacing is set as $\lambda_\sigma/2$, the length and tilt angle of each slot are selected properly by analyzing the impedance properties of each slot. Setting the impedance values similarly for all slots, the radiated powers from each slot are similar so that, the uniformity of the power loss distribution in the VOC filter is improved.

Figure 1 shows the VOC removal system using the proposed WSA satisfying the impedance-matching characteristics below $-20\,\mathrm{dB}$ at $2.45\,\mathrm{GHz}$. In addition, the normalized standard deviation (NSD) of the power loss distribution in the VOC filter is considered reduced during the design process. The NSD can be defined as a figure of merit of uniformity, which denotes the standard deviation of the power loss normalized by the mean value of the power loss in the VOC filter. It can be expressed as

$$\sigma_{nor} = \frac{\sqrt{\frac{\sum_{i=1}^{N}\left(P_i-\bar{P}\right)^2}{N-1}}}{\bar{P}} \tag{1}$$

where N is the number of samples and $\bar{P}$ is the mean value of the power loss distribution in the VOC filter. Fig. 2 shows the power loss distribution profile of the VOC filter that meets the NSD of the power loss profile of 0.736 in the VOC filter.

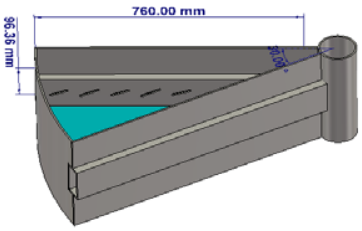

Figure 1: The proposed VOC removal system.

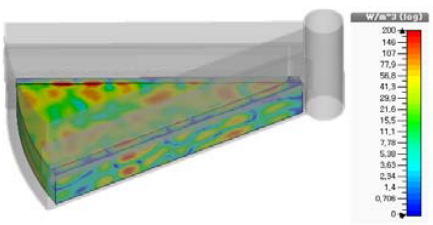

Figure 2: The power loss distribution in the VOC filter.

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