**347d Removal of Carbon Monoxide and Hydrogen from Air**

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Ultra high purity $N_2$ is required in the manufacture of integrated circuits to prevent defects in chips of increasing line densities. Cryogenic distillation is typically used for the production of highly purified Nitrogen gas. Almost all the $H_2$ and about 2/3rd of CO present in ambient air ends up in Nitrogen produced by cryogenic distillation. Even though very low levels of $H_2$ and CO, at most ~3000 and 5000 ppb respectively, are present in the ambient air these have to be removed from Nitrogen to about 1 ppb or lower levels prior to its use in semiconductor applications.

A two-step procedure is generally employed for the removal of these impurities from air in a Nitrogen production process. In the first step, a compressed feed gas is heated to temperature between 150„a and 250„a C and contacted with a noble metal catalyst to oxidize CO to $CO_2$ and $H_2$ to $H_2O$. In the second step, the oxidation products $CO_2$ and $H_2O$ are removed from the compressed gas stream by temperature and pressure swing adsorption process. However, with the almost universal adaptation of adsorption technology to pre-purify air prior to cryogenic distillation columns, it became obvious that if CO and $H_2$ could also be removed in the pre-purification unit a significant cost reduction could be realized (1).

We recently found (2) that the order of arrangement for different adsorbent and catalyst layers in these units have a profound impact on the performance of these units. Initially the layering arrangement in these pre-purification units was as follows: - First layer from the feed end to remove water, - Second layer to oxidize Carbon monoxide to Carbon dioxide, - Third layer to oxidize Hydrogen to moisture, and - Fourth and final layer on the product end to remove Carbon dioxide generated in the second layer and in the feed air, and moisture generated in the third layer.

However, changing the layering arrangement to: - First layer from the feed end to remove water, - Second layer to oxidize Carbon monoxide to Carbon dioxide, - Third layer to remove Carbon dioxide generated in the second layer and in the feed air, - Fourth layer to oxidize Hydrogen to moisture, and - Fifth and final layer on the product end to remove moisture generated in the fourth layer,

Improves the performance of the fourth catalyst layer almost five folds. This results in reducing the amount of catalyst required to oxidize Hydrogen to moisture. Being a noble metal catalyst such as Pd on Activated Alumina this catalyst is very expensive and a reduction in its requirement results in significant cost reduction. Reasons for this improved performance and its implications will be discussed.

(1): Jain, R. "Low Temperature Purification of Gases", US Patent 5,110,569, May 5, 1992. (2): Kumar, R. and Deng, S. "Purification of Gases", US Patent 6,511,640 B1, January 28, 2003.