Evaluation of various pitches 100-nm contact holes applying IDEALSmile with high NA KrF scanner

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Abstract

The industry demand for an extension of optical lithography using KrF and ArF exposure tools remains strong, concerning process maturity of NGL and the higher capital cost for implementing new tools. Many solutions exist for printing to print fine lines and spaces with k1 = 0.3 or smaller, these include the use of alt-PSMs, dipole illumination and other RETs. Moreover, the application of these RETs using NA0.85 ArF scanner enables feature shrinkage down to the 65nm Node.

However, contact/via holes are the most difficult features to successfully print according to the sizes dictated by ITRS road map. One of the primary reasons for the inability to maintain the same shrinkage pace is the resolution limitation due to two-dimensional diffracted light. Another factor is that, with the exception of negative-tone resist1, the complicated strong PSM (alt-PSM) applications have some difficulties to deploy.

In 2002, Canon demonstrated a new method, entitled IDEALSmile2,3, which simultaneously resolves 100nm dense and isolated contact holes while providing a robust process window. The advantages of the IDEALSmile technique are the high-resolution capability and the large process window with a conventional method such as single exposure using binary mask. In order to apply the IDEALSmile technique on actual device patterns, it is necessary to evaluate its through-pitch performance in terms of its process window, MEEF and etc.

Using the NA0.73 KrF scanner, greater than a 0.3um common process window was achieved for 120nm holes, ranging from 1:1 dense features through 1um pitch isolated features. Moreover, 0.10um dense holes were resolved with sufficient process window under the same exposure conditions.

These results lead us to conclude that, using the IDEALSmile technique, we can achieve a sufficiently large throughpitch process window for the 65nm node using a state-of-the-art NA0.85 ArF scanner.