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Growth of Ge quantum dots on Si(100) without a wetting layer

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When Ge atoms are deposited directly onto a Si(100) substrate, the growth follows the Stranski-Krastanov growth mode in which three-dimensional Ge islands, or quantum dots (QDs), are formed on top of three monolayer thick wetting layers. For many optical and electronic device applications, Ge QDs without the wetting layer may be highly preferred. Using a buffer-layer assisted growth approach [1], we have achieved the formation of Ge QDs on Si(l00) without a wetting layer. These QDs are shown to possess a narrow size distribution and are also substantially smaller than the QD hut clusters that are formed with the normal SK growth mode. Using the buffer layer approach, Ge QDs have been grown in a single layer and in multiple layers with silicon spacer layers as has been done with multilayers of conventionally grown Ge hut clusters. Due to the fact that growth in the buffer layer approach is well isolated from any stress effects associated with a preceding layer of QDs, it is not expected that the QDs in separate layers will exhibit any layer to layer alignment effects as observed for SK growth. However, the smaller size of the QDs obtained with the buffer layer approach may be expected to exhibit stronger quantum size effects. Initial tests with samples prepared by this approach show a strong photoluminescence signals in the IR that exhibit striking differences from PL results [2] obtained from Ge QDs grown by conventional means with a wetting layer.

[1] J. H. Weaver and G.D. Waddill, Science 251, 1444 (1991).
[2] M.W. Dashiell, U. Denker, and O.G. Schmidt, Appl. Phys. Lett. 79, 2262 (2001).

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