Ural, Griffin, and Plummer Reply: The preceding Comment [1] argues mainly that our values for the interstitial ($I$) and vacancy ($V$) components of Si self-diffusion at 800 °C are unreliable, and, therefore, activation enthalpies of $I$ and $V$ contributions to self-diffusion cannot be determined accurately. It follows that, if the 800 °C point is shifted, the $I$ and $V$ components at higher temperatures would agree with those extracted from metal diffusion experiments.

The “raw data” from which we have extracted activation enthalpies are the $I$ and $V$ mediated fractions of self-diffusion, $f_{SI}$ and $f_{SV}$, respectively. At 1000 and 1100 °C, we have shown that $f_{SI} = 0.5$–0.6. In contrast, Bracht’s latest metal diffusion results [2,3] suggest that $I$ dominates self-diffusion at 1100 °C with $f_{SI} = 0.84$ and $f_{SV} = 0.16$. Our data is most reliable at 1000 and 1100 °C, since we have perturbed both $I$ (using oxidation) and $V$ (using nitridation) and measured the effects on As, B, P, Sb, and self-diffusion as well as the intrinsic diffusivities of all five species [4]. Thus, our conclusion stands that $I$ and $V$ contribute approximately equally to self-diffusion.

At the lowest temperature of 800 °C, we have extrapolated from Arrhenius fits the intrinsic diffusivities for P and Sb, both of which are known to diffuse by a single dominant mechanism. Indeed, we have recently shown that $f_{SV} = 0.97$ at 800–1100 °C and $f_{PI} = 0.96$ at 1000 and 1100 °C [4], where $f_{SV}$ and $f_{PI}$ are the $V$ fraction of Sb and $I$ fraction of P diffusion, respectively. Furthermore, there is evidence that the ratio $f_{BI}/f_{PI}$, where $f_{BI}$ is the $I$ fraction of boron diffusion, is temperature independent in the range 900–1100 °C [5]. Gossmann’s and our work have also shown that $f_{BI} = 0.98$ at 1100 °C all the way down to temperatures on the order of 800 °C [4,6]. Based on these facts, it must be true that $f_{PI} \approx 0.96$ even at 800 °C. For intrinsic self-diffusion at 800 °C, we have taken, as a given, Bracht’s values [7], which we have reproduced between 900 and 1100 °C. Our Arrhenius fit agrees with Bracht’s within 8% at these temperature points. We take this as evidence that the intrinsic self-diffusion coefficient in Si is known to a high accuracy. By comparing the enhancement experienced by an interstitial diffuser such as phosphorus and by self-diffusion during oxidation at 800 and 900 °C, we have shown that $f_{SI} = 0.6$ at these temperatures.

It is a tribute to metal diffusion experiments that they have elucidated the important contribution of interstitials to self-diffusion long before it was generally recognized that both $I$ and $V$ are important for self-diffusion and dopant diffusion. Now, it is time to take the metal and dopant diffusion experiments and “weave a seamless logic [Hu]” that self-consistently explains both sets of results. Taking a step in this direction, we have fit the latest metal in- and out-diffusion experiments of Bracht et al. [2,3] by using the transport capacities of $I$ and $V$ extracted from our self-diffusion results, without significantly modifying any of the other fitting parameters [8]. Figure 1 shows the results. Finally, it is likely that the availability of isotopically enriched layers will further elucidate the details of the point defects in the future.

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