

Why Do Gallium clusters Hava a Higher Melting Point than the Bulk?

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This is a theory paper connected closely to recent experimental observations by at least two groups that certain metal clusters, namely of tin and gallium, melt at temperatures significantly HIGHER than the bulk. This is precisely the opposite of both the long-standing prediction by Rayleigh and the observations of virtually every other kind of cluster. The solution to this puzzle, about what makes gallium (and presumably tin) special is the remarkable phenomenon, according to these calculations, that the bonding of the atoms in these clusters is essentially covalent, not metal-like as it is in larger systems. The result opens a whole new set of questions about what kinds of properties we may find for nanoscale materials. The indication from these results is that there may be quite new bonding phenomena (as already indicated regarding other properties) that we have never seen in bulk matter. In fact, at the present time there is not even a rationale to let us guess what other materials might show this phenomenon.