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Growth angle - a microscopic view

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The growth angle that is formed between the side of the growing crystal and the melt meniscus is an important parameter in the detached Bridgman crystal growth method, where it determines the extent of the crystal-crucible wall gap, and in the Czochralski and float zone methods, where it influences the size and stability of the crystals. The growth angle is a non-equilibrium parameter, defined for the crystal growth process only. For a melt-crystal interface translating towards the crystal (melting), there is no specific angle defined between the melt and the sidewall of the solid. In this case, the corner at the triple line becomes rounded, and the angle between the sidewall and the incipience of meniscus can take a number of values, depending on the position of the triple line. In this work, a microscopic model is developed in which the fluid interacts with the solid surface through long range van der Waals or Casimir dispersive forces. This growth angle model is applied to Si and Ge and compared with the macroscopic approach of Herring. In the limit of a rounded corner with a large radius of curvature, the wetting of the melt on the crystal is defined by the contact angle. The proposed microscopic approach addresses the interesting issue of the transition from a contact angle to a growth angle as the radius of curvature decreases.