Singularities and their applications in materials science

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Singularities play an important role in algebra, analysis, and geometry. Many processes, particularly processes with jumps as Euler buckling in mechanical engineering and phase transition in thermodynamics, can be described via special singularities called elementary catastrophes. To describe phases under various conditions, we need phase diagrams. Unfortunately, these diagrams can only be constructed for systems with one, two, or three components. In the case of a multi-component system we have higher-dimensional surfaces. Based on singularity theory, in this work we present a method to construct two-dimensional diagrams even for higher-dimensional surfaces: the so called singularity graphs after Tamaschke. With these singularity graphs we reduce the geometrical information of a surface to isotypes. Furthermore, it is possible to construct a new kind of phase diagram for arbitrary systems. Eventually, we simulate the characteristic behaviour of the components in relation to the control parameters.

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