



UNIVERSITÀ DEGLI STUDI
DI TRENTO

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Room A107 – Polo Ferrari 1

Local order and thermal history in complex metallic materials: from high-entropy alloys to metallic glasses

Abstract:

Chemical short-range order (CSRO), although thermodynamically driven, is usually the kinetically frozen imprint of an alloy's cooling history. Interest in its study has expanded markedly over the last decade, especially in compositionally complex alloys (CCAs), including medium- and high-entropy alloys, and in connection with mechanical properties, yet it remains an elusive feature that is difficult to characterize. This contribution highlights a few laboratory-accessible probes of CSRO in single-phase solid solutions that complement large-scale facility-based structure determination. After a concise overview of the main scattering and spectroscopy methods useful for resolving local structures and chemical ordering –such as X-ray absorption spectroscopy– the talk focuses on differential scanning calorimetry, dilatometry, and electrical resistivity measurements performed on benchmark compositions such as equiatomic CrCoNi. These laboratory-based experiments register subtle CSRO-related signatures in heat capacity, thermal expansion, and charge-carrier scattering, enabling rapid screening, in-situ thermal cycling and kinetic studies.

Typical hurdles in multicomponent systems –weak scattering contrast among neighboring elements and an excess of refinable parameters– are mitigated when laboratory data are incorporated into the analysis alongside complementary large-scale facility data. Emerging evidence shows that CSRO has a measurable impact on thermophysical responses, whereas its effect on bulk mechanical performance appears modest, if not negligible, in the systems studied so far.

This cooling-history perspective also provides a natural link to metallic glasses and devitrified glass-forming alloys. In the final part of the seminar, first results on a Zr–Cu–Al model system will be discussed to show how local atomic environments evolve from the amorphous to the crystallized state, revealing element-specific differences in local structure across the amorphous-to-crystalline transformation.

Overall, the seminar will discuss how rigorous control and reproducible formation of local order, coupled with reliable structural determination, can help untangle processing–local-structure–property relationships in complex metallic materials, from crystalline CCAs to metallic glasses.

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