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Exploring nanomultilayers for joining technology

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In response to the ever-increasing requirements for joining processes and joint performance, specially designed nanomultilayers (NMLs)have been explored as new materials for the joining technology application. To this end, nanolayers (<20 nm) of brazing filler metals and metal alloys, such as Ag, Cu, Ag-Cu and Al-Si alloys, were confined between chemically inert barrier nanolayers (AlN, W,C)for the use as a bonding material.The comprehensive experimental study of the NML's phase stability and atomic mobility upon heating shows that the nanosized brazing filler metals may exhibit a significant melting point depression in combination with a high atomic mobility along NMLs internal interfaces (i.e. phase and grain boundaries).The observedfast directional "outflow" of the confined metal to the NML surface at temperatures can be controlled by the NML design (material composition, layer thicknesses, interface structure, internal stresses),deposition parameters and environmental parameters, as well as NMLs surface pre-treatment. Finally, this effect can be utilized for bond formation or surface patterning.

When using nanomultilayers of immiscible metallic systems - such as Cu-W -as bonding materials, high-strength nanocomposites can be formed in-situ during the joining process, which offers a new route to create joints with excellent mechanical properties.

Another example of nanomultilayers with significant potential for the joining technology are NMLs based on reactive materials such as Ni/Al, serving as a local heating source and allowing nearly "room-temperature"soldering and offering many opportunities for joining of heat-sensitive materials as for example nanostructured metals and alloys.

The obtained fundamental knowledge on the phase stability and atomic mobility of confined solids in nanomultilayersis not only relevant for joining technology but also for many other application areas, such as hard coatings, optical filters, X-ray mirrors, energy storage, micro-electronics and plasmonics.

Helium in metal nanocomposites