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Solid Surfaces - Impact on Mechanics and Mechano-Chemical Coupling in Small-Scale Systems

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It is widely acknowledged that the deliberate structuring at the nanoscale provides opportunities for tailoring a materials behavior by mixing interfacial contributions into the otherwise bulk-dominated behavior. The mechanical behavior of nanomaterials, and specifically the strengthening at small scale, exemplifies the power of this strategy. While "smaller is stronger" is empirically well documented, the underlying mechanisms remain poorly understood from a microscopic point of view. There are also reports of an impact of the microstructural scale on the elastic materials' response. Yet, while the relevant mechanics appears understood, the empirical database on elasticity of nanomaterials is sparse. This applies equally to experiments probing the excess elasticity (if any) of free surfaces and to those experiments which probe the elastic response of internal interfaces such as grain boundaries. The talk will address selected approaches to measuring surface and interface contributions to the mechanical behavior: surface excess stiffness[1] and grain boundary excess compliance[2] connect to the elastic response, whereas interfaces contribute to plastic deformation via the impact of surfaces on strength,[3] and via dislocation climb during grain rotation.[4]

A key idea behind recent experiments in the field is that the mechanical chemical or mechanical electrochemical coupling at interfaces may be exploited for inducing reversible variations in the local mechanical behavior, selectively at surfaces or interfaces. This provides reliable experimental signatures of interfacial contributions to the material's behavior that are not accessible by classic testing schemes. The strategy also advertises the strength of the electro-chemo mechanical coupling at interfaces. This phenomenon is as yet poorly investigated by experiment or theory, yet it provides opportunities for exciting scientific studies, and specifically it may be used to strongly affect materials behavior, thereby creating nanomaterials with entirely new functionality.[1,3,5]

1. N. Mameka, J. Markmann, H.-J. Jin and J. Weissmüller, Acta Materialia 76 (2014) 272.
2. J. Weissmüller, J. Markmann, M. Grewer and R. Birringer, Acta Materialia 59 (2011) 4366.
3. H.J. Jin and J. Weissmüller, Science 332 (2011) 1179.
4. D.V. Bachurin, A.A. Nazarov and J. Weissmüller, Acta Materialia 60 (2012) 7064.
5. J. Weissmüller, R.N. Viswanath, D. Kramer, P. Zimmer, R. Würschum and H. Gleiter, Science 300 (2003) 312.

The *Materials Science and Technology Seminar* is jointly organized by *ICAMS* (Interdisciplinary Centre for Advanced Materials Simulation) and the *IfM* (Institute for Materials). Members of the *RUB Materials Research Department MRD* and of the *DGM Regionalforum Rhein-Ruhr* are cordially invited to participate in the seminar. For further information, please contact: Mrs. Grace Raatz raatz@wtech.rub.de , phone: +49 234 32 25952.

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