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Preface

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This volume contains most of the papers contributed to the International Workshop on Interfaces: ''Interfaces by Design'' held on June 26–30, 2005 in Santiago de Compostela, Spain. About 90 invited scientists from 13 countries participated in the Workshop. New results were reported in 34 oral contributions, 30 poster presentations and many vigorous discussion meetings.

Conferences on ''Interfaces'' have been held in Spain on five previous occasions—in 1990, 1993, 1996, 1999 and 2002. The first conference in 1990 emphasized the importance of characterization. The second conference in 1993 stressed the correlation of processing, properties, and characterization with an emphasis on ceramic/metal interfaces. The proceedings were published in *Scripta Metallurgica et Materialia*, 31(8), 1994. The third conference in 1996 dealt with the role of interfaces. The proceedings were published in *Acta Materialia*. The fourth conference took place in Sevilla, in 1999 and examined the progress on ceramic and biomaterial interfaces. The proceedings were also published in *Acta Materialia*. The fifth conference took place in Oviedo, in 2002 and summarized the progress in the field during the last 3 years. The proceedings were published in *Journal of the European Ceramic Society*. Each meeting summarized the state of the art, defined the key outstanding problems, and promoted collaborations and exchanges that helped advance the field during the ensuing years. The conference in Santiago in 2005, ''Interfaces by Design,'' summarized the progress in the field over the last 3 years. It also served as a benchmark of accelerating progress in materials interfaces.

The purpose of this International Workshop on Interfaces was threefold: summarize the progress made in the science of interfaces over the last 3 years; provide a forum for discussing the fundamental properties of materials interfaces in a wide spectrum of applications (including composites, microelectronic packaging, materials joining, functionally graded systems, thin films, and biomaterials); and, through new insights gained from researchers with very diverse backgrounds and points of view, advance our understanding of the common aspects of materials interfaces in these widely differing fields to stimulate new developments and breakthroughs for the forthcoming decade. The inherently interdisciplinary nature of interfacial phenomena extends through materials science, physics, chemistry and mechanics, spanning a broad range of materials.

Interfaces are a key to the performance and stability of materials from structural and biomaterial composites, through electro-optical devices down to nanostructures, where the influence of interfaces is inescapable. Control of these interfaces presents innumerable opportunities for exploitation to improve material performance. Indeed the presence of multilayer boundaries that are atomically disordered after fabrication but which can be ordered thermally to strongly influence properties has motivated a new design strategy, namely that interfacial structures themselves can experience temperature or adsorbate driven transformations and that these structures can be manipulated to induce radical changes in the properties of advanced ceramic materials. Such interactive investigation of multiple interfaces will yield major contributions to a badly needed comprehensive science of internal interfaces, and, thereby, also to contribute to the dream of materials and interfaces by design.

The next decade should provide the opportunity to develop a rigorous and refined science of internal interfaces in a manner that will contribute to the design and fabrication of materials and structures with unique properties and unprecedented reliability and durability. This opportunity arises by virtue of advances in the comprehension of interfaces, realization of the wide scope of possible interfacial structures and behavior that could actually exist, dramatic improvements in the ability to characterize interface composition and structure quantitatively, recent advances in the ability to compute and model interfacial structures and their effect on properties over various length scales, and a comprehensive suite of novel methods for assessing macroscopic, interface dependent properties.

Specifically, as a consequence of scientific opportunities and new generations of experimental methods, materials sciences will entail an assault on composition, structure, stability relations for incoherent ceramic and ceramic/metal interfaces and the relations to other properties. Relationships of interface structure and composition will be developed to other properties, especially interfacial energies, kinetics and transport and also adherence in the broadest sense (from interfacial fracture mechanics to liquid spreading dynamics), while continually seeking the coupling between atomistic processes and resultant macroscopic behavior. The implications of this research will be in the design, fabrication and durability of structural and functional materials and devices.

Finally, it is apparent that as we enter the 21st century, the field of biomaterials has become one of the most intellectually exciting areas of materials science. The main objective has become the design of materials that can interact with the biological environment for a given purpose. A major class of biomaterials is essentially temporary ''anchoring scaffolds'' to which specific types of cells can colonize and evolve into three-dimensional tissues. The objective is to help biology regenerate the missing or dysfunctional body parts by providing biodegradable substrate. Research worldwide focuses on the development of a new generation of biomaterials. The goal is to develop new organic–inorganic (ceramic) nanoscale composite materials with a wide range of controlled properties using a biomimetic synthetic approach applicable for clinical treatment of oral, craniofacial, and orthopedic bone defects.

With this background in mind, the Santiago Workshop provided a forum for discussions of fundamental properties of solid/solid and solid/liquid materials interfaces in the context of a spectrum of applications, including composites, microelectronic packaging, thin films, materials bonding and joining, FGM systems and biomaterials. The organization of this volume follows that of the Workshop with sessions on theory of interfaces, wetting and spreading, biomaterial interfaces, oxide–metal interfaces, thin films, interfaces in composites and interface structure and composition. A special session was also held during the Workshop honoring Professor Dr. Manfred Rühle, titled ''Grain Boundary Structure, Composition, and Stability.''

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Finally, we would like to thank Professor Francisco Guitian for his effort in making local arrangements in Santiago. We look forward to an exciting next Interface Workshop to be held during the last week of June in Spain in 2008.

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