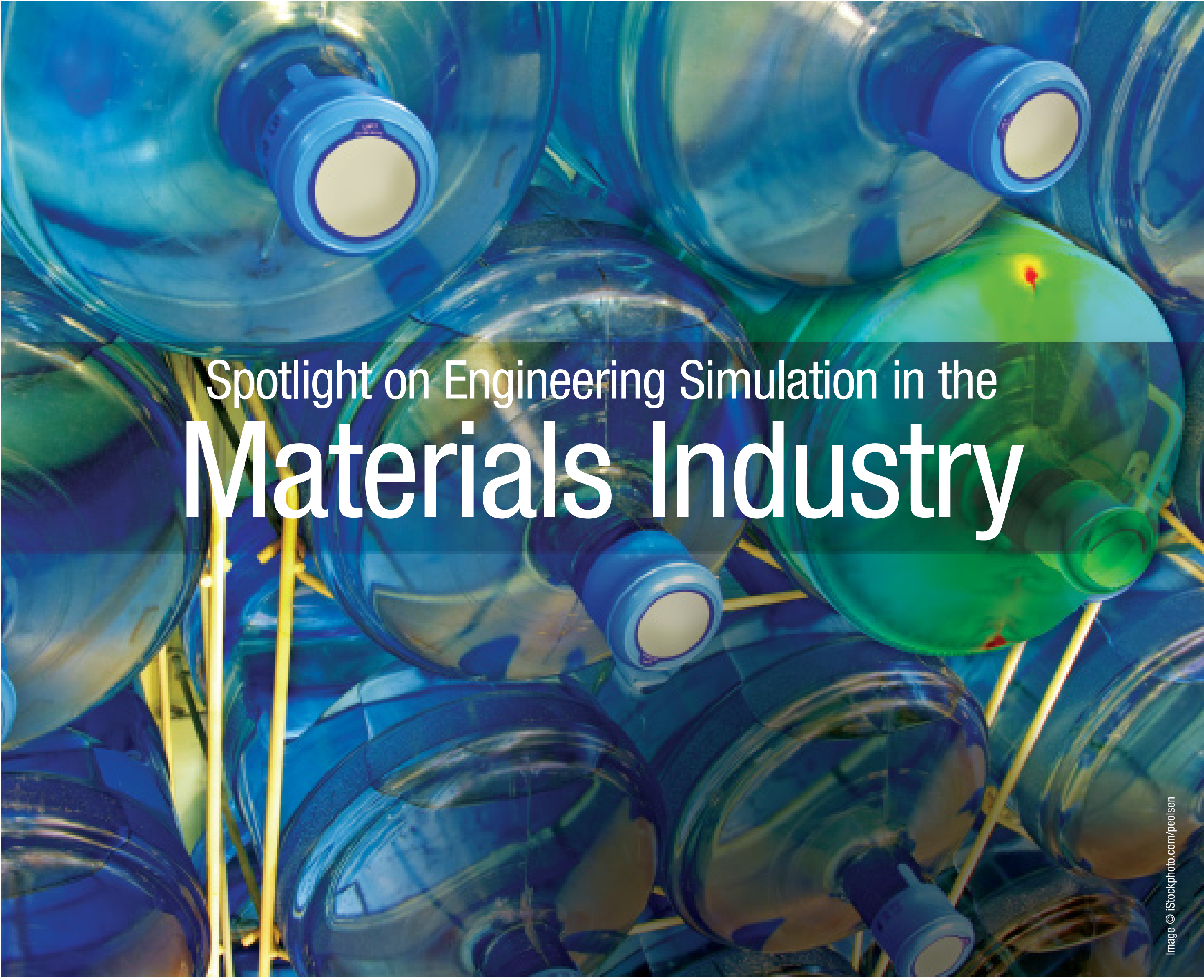

POLYFLOW simulation of the blow molding of a 20-liter water bottle.

Pushing the Limits of Materiality: **The Virtual Prototyping Solution**

Materials are continually being improved to address the challenges of the 21st century in a fiercely competitive world.

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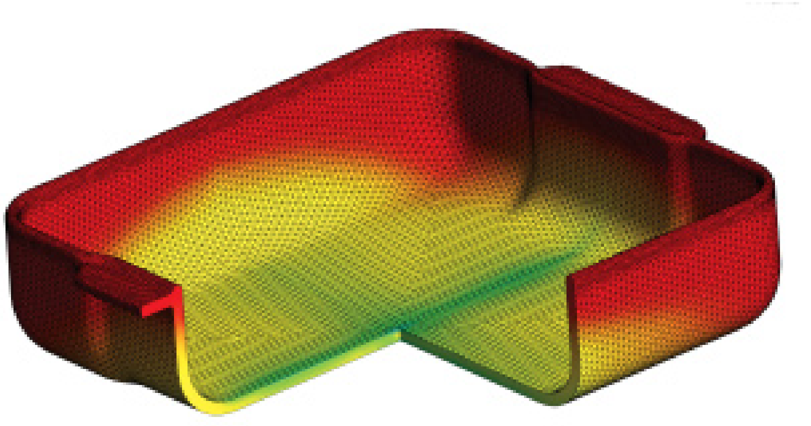
The Challenges of the Materials Industries

Metals, glass, polymers, cement, wood, composites and other materials are the embryos of manufactured products — including airplanes, cars, electronic components, offshore platforms and medical devices. In supporting these products, the materials industries are at the core of the global economy. Getting better product performance often requires pushing for quality improvements of raw materials or switching to a totally new material. These industries, usually seen as employing traditional development processes, are in fact using some of the most advanced modeling techniques to continually improve manufacturing techniques and products and to create new materials with amazing properties. Numerical simulation has progressively demonstrated its importance as a critical technology for success in this fiercely competitive, though cautious, market.

Innovations and New Materials

The most impressive progress and breakthroughs have been the result of ideas that seemed, at the beginning, unlikely to lead to a major step forward. In today's extremely competitive environment, these innovations are more important than ever. In a risk-averse market, however, it is sometimes difficult to find the necessary flexibility and



Temperature distribution during the cooling of a dish. Using the Narayanaswamy model, it is possible to detect the peak stress related to the emergence of defects at the core of virtual glass products.

resources to demonstrate the potential of a new concept. Numerical simulation plays a role in the materials industries at every scale — from the study of how nanotechnology can touch the very structure of materials to the macroscopic-scale, hazard investigation of entire manufacturing facilities. Simulation is used to test potential innovative solutions to problems without jeopardizing business or safety. The emergence of new airplanes with much higher fuel efficiency [1], the design of a new race car or America's Cup yacht [2] and the development of advanced processes for extracting titanium [3] are all illustrations of this trend.

Seeing to the Core of the Manufacturing Process

Beyond these innovative activities, numerical modeling is used widely to improve, adjust, or troubleshoot existing processes, as well as for the routine inspection of existing device performance. These tasks are far from trivial, not because designers lack skills, but due to insufficient information such as local flow patterns or peak stresses at the core of the manufacturing device. Only supernatural powers or computer-aided engineering (CAE) modeling permit designers to actually see inside the solid structure to detect problems, such as possible excessive stress and risk of rupture due to fatigue, or specific flow recirculation that can lead to the dissolution of tiny additives in an aluminium furnace. Access to this type of information provides the designer with the necessary additional understanding to more easily improve a given process or fix an unfortunate problem.

Virtual Prototyping

While numerical modeling already has seen early successes in the materials industries, this solution alone is no longer sufficient to provide a clear lead in highly competitive markets. The innovators and successful players of the modeling world are now involved extensively in optimization analyses and parametric studies, not to mention Six Sigma analysis, in order to identify an optimized design before actually manufacturing any part. Experimental efforts are now part of the virtual world as well: Drop test, mechanical testing and behavior under normal or extreme service conditions are simulated on virtual prototypes. Virtual representations of new parts are completely designed, manufactured and tested before actually moving to the real world, with only the most promising prototypes making it into production.

Simulation Driven Product Development

The different steps described above have been used routinely in the materials industries with growing success, as the physics involved and the robustness of the solution were improving during the last few years. The trend that is clearly emerging is the need to integrate these different product development stages into a seamless virtual environment. Some solutions, such as the ANSYS Workbench platform, have been successfully developed to address this new requirement. These solutions are opening the door to the emerging concept of Simulation Driven Product Development. SDPD enables a new plastic part, a glass bottle or a concrete building structure to be modeled throughout an entire development process — from raw material production, to end-user part manufacturing, to final testing — in a common, unified environment.

We are at a threshold at which the virtual world will allow us to go seamlessly from conceptualization to end-product modeling, tracking every opportunity to produce better materials faster, cheaper, more safely and with a more environmentally friendly approach than ever before. ■

References

[1] "Software Delivers Faster Time-to-Part and Reduced Testing," *Reinforced Plastics*, Sept. 2007, pp 24-25.

[2] "The Simulation Race for America's Cup," *ANSYS Advantage*, Vol. I, Issue 2.

[3] "Tweaking Titanium's Recipe," *The Wall Street Journal*, Online, Sept. 10, 2007.

[4] "Modeling Dies for Rubber Parts," *ANSYS Advantage*, Materials Spotlight, Vol.1, Issue 4.