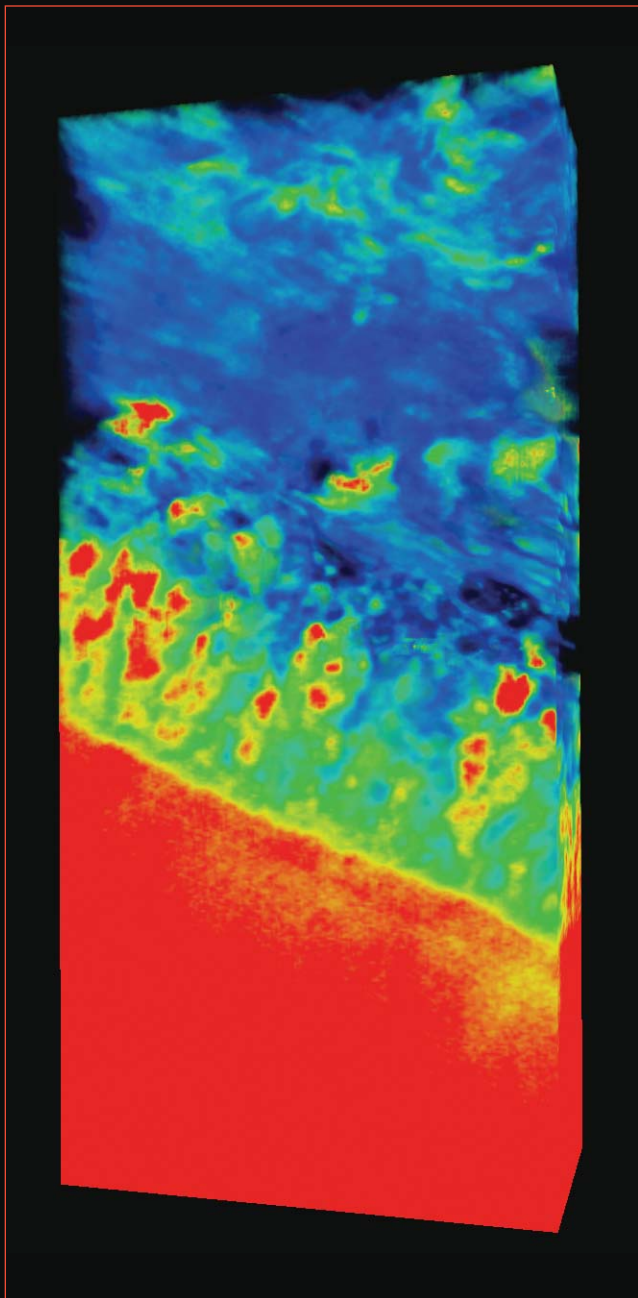




Where bone meets implant

The success of joint replacements and dental implants depends critically on osseointegration—the formation of a direct interface between the implant and living bone. Without such a structural connection, the soft or fibrous tissue that develops around the implant can admit differential motion, compromise the interface's mechanical stability, and cause the implant to fail. But understanding the key elements of the osseointegration process goes beyond the capabilities of exam-room x rays. Micro- and nanostructured surfaces, for example, can drastically improve the level of integration. New three-dimensional imaging techniques are helping researchers uncover the mechanisms contributing to effective bonding.

Using a technique known as electron tomography to study bone-implant interfaces, Kathryn Grandfield and colleagues at the Canadian Centre for Electron Microscopy in Hamilton, Ontario, have recorded hundreds of transmission electron microscope (TEM) images and assembled them into 3D models with 5-nm resolution. Shown here is one such reconstruction, of a titanium screw that had been implanted in a rabbit's leg for six months. On the surface of the titanium screw (red) is a 100-nm-thick oxide layer (green, yellow) that had been roughened by a pulsed laser. The bone structure (blue) that formed after implantation can be seen penetrating into the nanostructured surface. The researchers could visualize the interface constituents semi-quantitatively thanks to the compositional contrast inherent in the raw TEM images: The image intensity is roughly proportional to the square of the local average atomic number Z . (K. Grandfield, S. Gustafsson, A. Palmquist, *Nanoscale* **5**, 4302, 2013; image courtesy of the Grandfield lab, McMaster University, and Anders Palmquist, University of Gothenburg.)

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