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Mechanical contacts probed with picosecond ultrasonics

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We investigate the contact between a thin metal film and a ball bearing indented to nanometre depths using picosecond ultrasonics. The area of contact is acoustically imaged to micron spatial resolution using GHz acoustic pulses produced by ultrashort pulsed optical excitation of the film through a transparent substrate. In particular, acoustic echoes are detected through transient optical reflectance changes that are monitored by probe optical pulses. In this way we image the acoustic reflection coefficient at the interface between the film and the indenter. In addition, by imaging the arrival time of the acoustic echoes we determine the penetration profile of the indenter to nanometre precision. Furthermore, imaging the transient thermoreflectance gives a different means for measuring the contact area through spatial variations in thermal diffusion. We thus demonstrate that picosecond ultrasonics and thermoreflectance provide powerful tools for the non-contact evaluation of mechanical contacts. These techniques could be applied to the in situ characterization of contact interfaces between machine elements.