Using Varian Analytical Instruments Liberty 100 air pass ICP, minimum detection limits better than 1 ppb by weight (element-/line-dependent), bulk solid acid digestion (for powders, residue, ingots, and so on) and liquid analyses can be performed. Analysis of all elements from Li to U (excluding N, O, F, S, and noble gases), 0.75-m Czerny Turner monochromator with holographic grating allows high-intensity spectra up to four peak orders, with 0.006-nm resolution through a wavelength range of 189–900 nm.

- Surface analysis (AES/XPS): Electron spectroscopy for elemental analysis of surfaces, sensitive to as low as two atomic layers. Physical electronics model PHI-570 Auger Electron Spectroscopy/X-ray Photoelectron Spectroscopy System is a double-pass cylindrical mirror energy analyzer with dual anode (Mg/Al) X-ray source and has a rapid sample introduction probe. It can detect elements at the first 5–10 atomic layers of sample and detect all elements, except H and He.
- Scanning electron microscopy for high-resolution and high-magnification photographs. It can also perform elemental analysis with EDS and WDS attachments. JEOL JSM6320F and JSM-35C research-grade SEM can provide imaging from 10× to 400,000×. Using analytical electron microscopy, very-high-magnification images with excellent depth of focus can be obtained. This is especially important when rough-surface structures are being examined. In addition, information about the chemical composition at the microlevel and the phase composition of the sample under study can be obtained directly. Using SEM, such as the Fraunhofer Institut Für Fertigungstechnik und Angewandte Material for Schung, it is possible to magnify structures up to 500,000 times with high depth of focus. A finely focused electron beam allows structures down to 0.001 mm to be resolved. The acceleration voltage of the electron beam directed at the sample surface can be varied between 300 V and 30 kV. The emitted secondary and backscattered electrons give information about the topology of the sample. Backscattering electrons can also be used to produce material-contrast images.
- X-ray diffraction (XRD) for phase analysis, crystallographic information, residual stress, texture analysis, and reflectometry on powders, bulk, or thin films. Philips X'Pert PRO and a second Philips dual diffractometer system with automated PC control, independent $\theta/2\theta$, sample spinner, and 21 sample changer can be used for crystallography and Rietveld analysis of samples—flat, irregular, thin films, or in glass capillaries.
- Fourier transform-infrared spectroscopy (FT-IR) is useful for identifying organic and inorganic compounds by comparison with library references. Perkin Elmer System 2000 offers near-IR, mid-IR, far-IR: 15,000–15,030 cm, transmittance (T), specular reflectance (SR; Ref. 6) and diffuse reflectance (DR), horizontal and vertical attenuated total reflectance (ATR) microscope (>10 μm spot, 10,000–10,580 cm)$^{-1}$.

3.5.3 Thermal Analysis

Material characterization requires the measurement of molecular and macroscopic properties. Thermal analysis techniques determine calorimetric and mechanical