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No Crime is Perfect

New crime investigation methods

Scientific technology has provided forensics with crime investigation breakthroughs in the 20th century. Thanks to the evaluation of fingerprints and evidence, to the development of DNA analysis, microscopic and spectroscopic techniques, as well as image-analysis techniques, the rate of crimes solved has risen significantly. The LKA (State Investigation Bureau) of Saxony, a German state in the southeast of the country, combines electron microscopy, spectroscopy and image analysis, to evaluate beads of metal which occur when cracking open safes with a welder. The data acquired provides investigators with critical data on the crimes committed.

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Hot work

„Burglars crept in last night and cracked open the safe with a hot-work approach“. These kinds of statements appear again and again in newspapers. „Hot work“, is police lingo for when welders and disc cutters are used to break open safes. After car break-ins, apartment and house break-ins cause the greatest amount of damage to German citizens. It‘s no surprise the police expend so much effort in putting a stop to the perpetrators of these crimes. New spectroscopy- and microscopy-based techniques can provide investigators with important clues and evidence for apprehending criminals.

Keeping the safe safe

Safes are certainly the place to keep important documents, valuables and cash. A good safe not only protects its contents from fire or environmental damage, it also keeps the contents out of the wrong hands. Special tools are necessary to break open a safe. Your average burglar does not usually carry these around when breaking into a private household. Even when the thieves have some familiarity with safes, they need some time to force them open – and time is something they usually do not have. But there are burglars that are safe-cracking specialists. Burglars may take the safe with them, force it open, batter or weld it open – or simply open it when the key is found right there in the house/apartment.

Figure 1: FEI Quanta 600 F scanning-electron microscope with EDX and WDX detector

The LKA (State Investigation Bureau) in Saxony

One of the LKA‘s jobs is to professionally monitor criminal detection activities of the Saxon police departments. As the highest state police agency, the LKA in Saxony is headquarters for crime detection tasks and police enforcement in the state of Saxony. The agency currently employs 800 people from a broad array of professions. Alongside enforcement agents and administrative personnel, there are lawyers, sociologists, computer experts and scientists making their contribution towards LKA success. One of them is Thomas Scholz, a physicist at the KTI (Technical Institute for Forensics). Armed with the latest in equipment, he and his colleagues undertake their quest for evidence to apprehend offenders.

Metal beads provide a clue

Burglars often create (and leave) total chaos where they break in. „Although this makes a conventional search for clues much more difficult“, as Scholz explained, „there are always indicators left behind that one can use to help find out what happened.“ Usually these traces are not readily visible. Special techniques and equipment are required to find these and visualize them. This is where new techniques and methods are providing investigators with tremendous help in making advances. And persons involved in fraudulent or other criminal activity do not overlook the latest technology either. „However, you can be assured that we have better resources available to us“, according to Scholz. It‘s this highly effective combination of modern electron microscopy with electron beam microanalysis, mass spectroscopy and digital image analysis at the LKA in Saxony which opens up totally new opportunities for analyzing evidence.

Important pointers

Breaking open a safe with a welder or disc cutter results in metal beads with a characteristic shape. These tiny little particles can be found not just at the scene of the crime, but also on the clothing and tools of the perpetrators. The analysis of the composition of these particles and comparing them can provide important indicators for apprehending the culprit(s). The material of a common safe mainly consists of unalloyed structural steel as used in many products. In

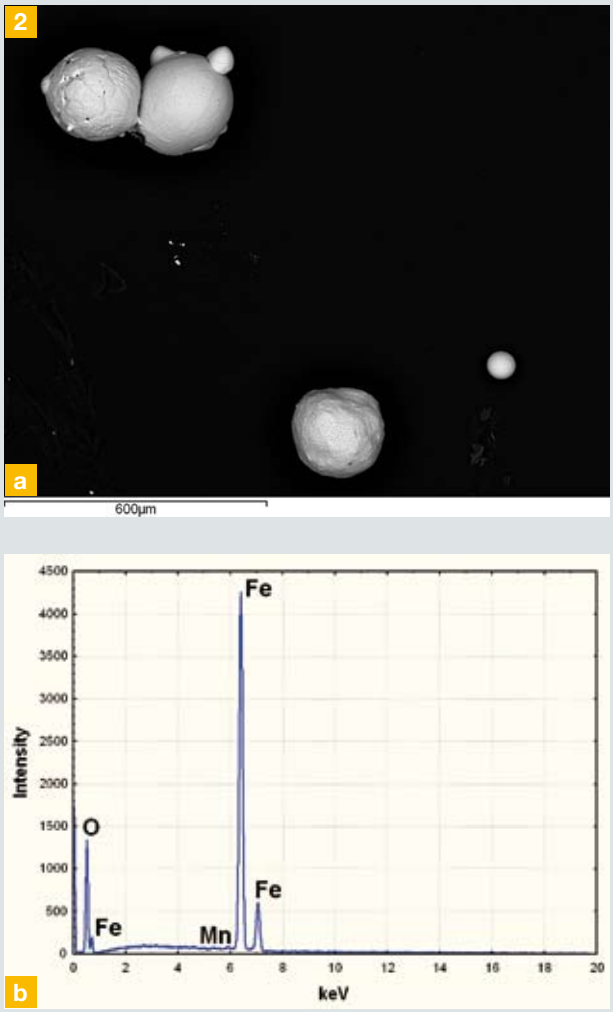

Figure 2: a: The kind of beads occurring due to welding or disc cutting, b: EDX spectrum of a bead – only the main components are visible here.

order to distinguish between various samples of this material, the LKA in Saxony uses electron beam microanalysis for determining the primary components along with LA-ICP/MS (Laser Ablation Inductively Coupled Plasma Mass Spectrometry) for determining trace elements. „If we can prove that the beads from the scene of the crime match the ones on the clothing of the suspect, then we have gained an important detail in establishing a burden of proof“, explains Scholz.

By process of elimination

In its extensive investigations, the LKA in Saxony uses a modern scanning electron microscope (Quanta 600 F, FEI Company) with integrated EDX and WDX electron beam microanalysis (Oxford Instruments). In cooperation with the Thermo Fisher Scientific company, they use a LA-ICP/MS system (X Series 2). Software for image acquisition, archiving and image analysis (Scandium by Olympus Soft Imaging Solutions) is deployed as well (figure 1). The first step is taking samples gathered at the scene of the crime and from the clothing of the suspect, slipping them into the

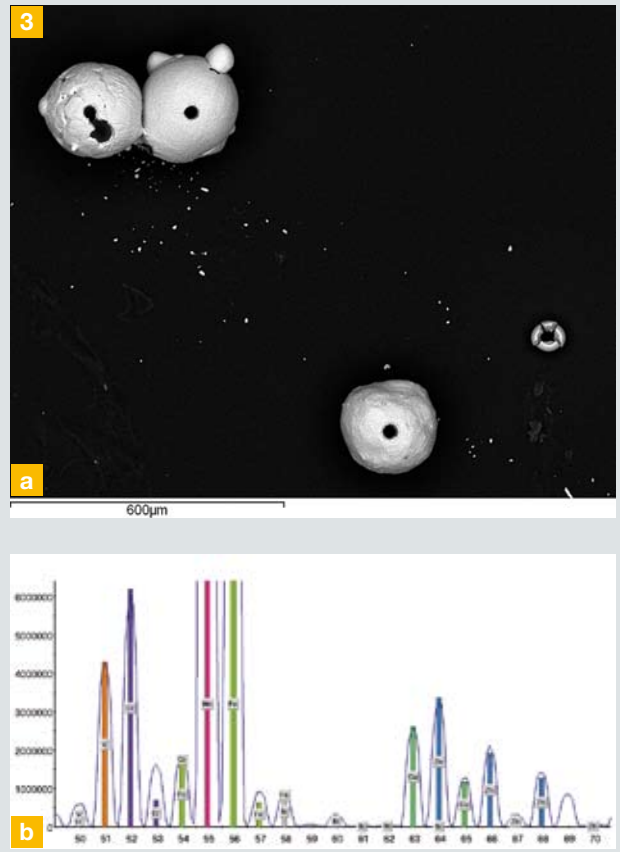

Figure 3: a: Beads according to LA-ICP/MS measurements, b: Mass spectrum (excerpt) of a steel bead .

microscope and examining them for any possible beads (fig. 2a). Once any are found, that‘s when the actual work starts. „Using electron beam microanalysis, we can quickly determine the primary components of the beads and immediately begin an initial process of elimination“, explains Scholz (fig. 2b). The next step is only taken if the EDX spectra of both samples show significant congruence. That next step is determining trace elements.

The search for trace elements

„LA-ICP/MS spectroscopy is a very promising method for determining trace elements“, notes Scholz. This method involves a pulsed laser removing material from the bead. This material is then ionized and the elements present and their isotopes are subsequently determined in a mass spectrum (fig. 3a, b). To optimize laser removal parameters, the depth of the resulting crater is of interest as well as the lateral extension. The depth is determined using stereomicroscopical SEM acquisitions. „That‘s really easy to do quickly using Height, the Scandium extension“, says Scholz (fig. 4). All of these steps ensure comparable conditions to obtain irrefutable results. Comparing the mass spectra of the beads at the crime scene with beads from suspects‘ clothing or tools provides investigators with that irrefutable evidence for apprehending offenders.

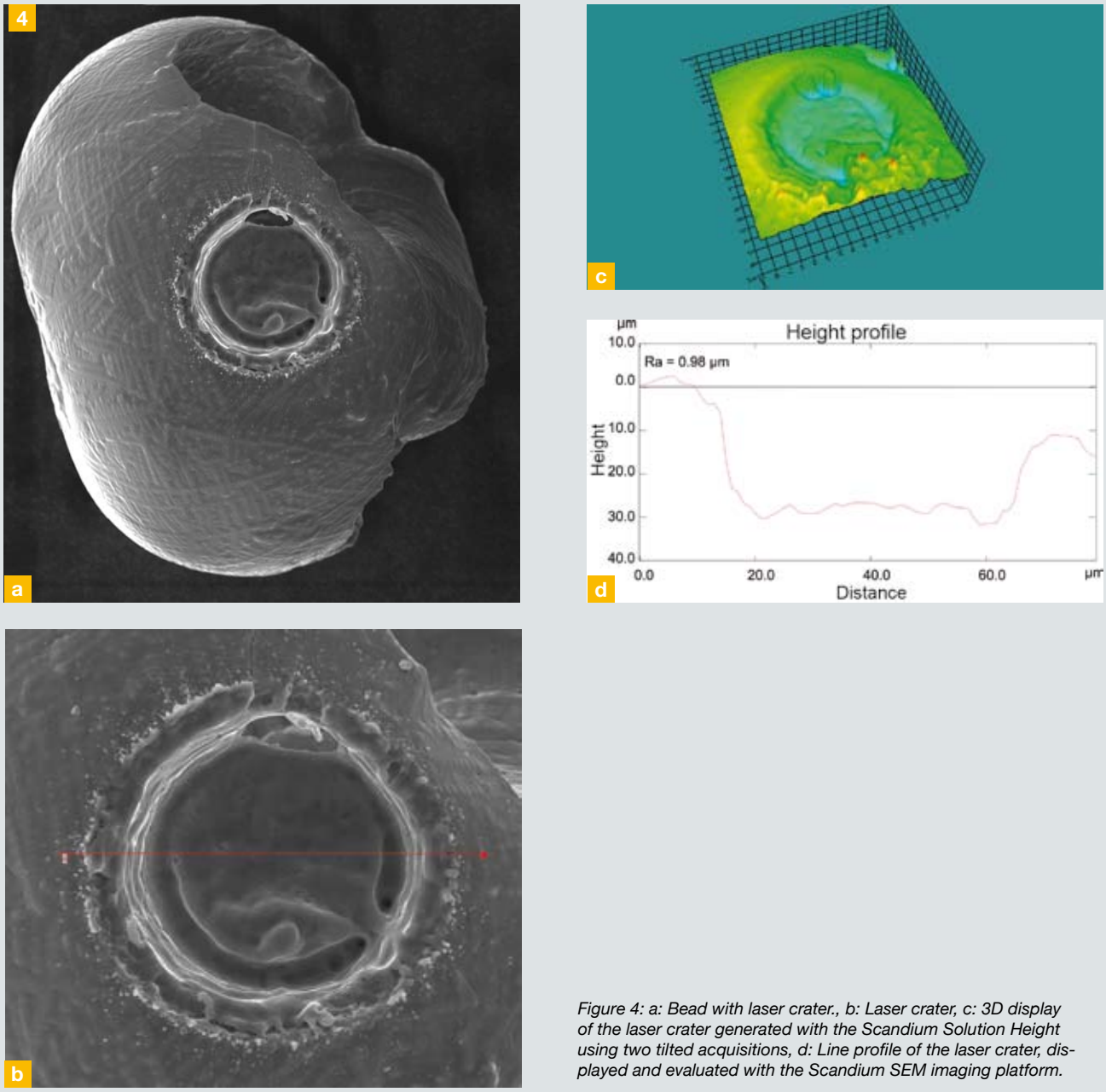

Figure 4: a: Bead with laser crater., b: Laser crater, c: 3D display of the laser crater generated with the Scandium Solution Height using two tilted acquisitions, d: Line profile of the laser crater, displayed and evaluated with the Scandium SEM imaging platform.

Conclusion

Breaking open a safe with a welder generates microscopically tiny beads of structural steel. These beads provide investigators with critical information for apprehending suspects. Combining various microscopic and spectroscopic techniques is crucial for the investigators at the LKA in Saxony, enabling them to travel new and effective avenues towards solving crime.

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