Experimental determination of surface emissivity for military equipment components and comparison with reference data

Lazar Z. Lazarević[a], *Nebojša* P. Hristov[b], *Damir* D. Jerković[c], *Darko* R. Latinkić[d], *Mihael* M. Bučko[e]

University of Defence, Military Academy, Belgrade, Republic of Serbia

[a] e-mail: llazarevic995@gmail.com,
ORCID iD: https://orcid.org/0000-0003-1949-2685

[b] e-mail: nebojsa.hristov@va.mod.gov.rs,
ORCID iD: https://orcid.org/0000-0002-8163-2223

[c] e-mail: damir.jerkovic@va.mod.gov.rs,
ORCID iD: https://orcid.org/0000-0001-5182-7057

[d] e-mail: darkolatinkic@gmail.com,
ORCID iD: https://orcid.org/0000-0003-4952-123X

[e] e-mail: mihael.bucko@va.mod.gov.rs, **corresponding author**,
ORCID iD: https://orcid.org/0000-0001-6992-8841

doi https://doi.org/10.5937/vojtehg74-61524

FIELD: materials
ARTICLE TYPE: original scientific paper

Abstract:

Introduction/purpose: The aim of this paper was to investigate the emissivity of materials relevant to the Serbian Armed Forces and to assess their role in infrared signature management and camouflage performance. Emissivity is a critical parameter influencing the thermal detectability of objects, as surfaces with higher emissivity emit more infrared radiation and thus become more visible to thermal imaging systems.

Methods: In this study, emissivity values of textiles, wood, metals, and polymeric components were measured using a FLIR-based thermographic method. The applied approach proved to be fast and reliable, with results consistent with established reference data.

Results: Differences between material classes were evident: textiles and polymers generally showed high emissivity, metals displayed lower values strongly affected by surface treatments, while wooden elements

ACKNOWLEDGMENT: The authors would like to acknowledge support from the scientific projects of the Military Academy, University of Defense in Serbia: “Research on influence of characteristics of explosive ordnance on safety in Ministry of Defense and Army of Serbia” (VA-TT/1/22-24), and “Improvement of ballistic testing in the design phase of weapon systems and ballistic protection” (VA/TT/1/24-26).

remained highly emissive and therefore more exposed to detection. These findings confirm that emissivity is highly dependent on material type, surface finish, and applied coatings.

Conclusion: The results provide a comprehensive dataset for military-relevant materials and highlight the practical importance of emissivity characterization in the development of effective camouflage strategies. By integrating accurate emissivity data into infrared signature modeling, it becomes possible to optimize camouflage design and improve operational survivability by reducing the probability of detection on the battlefield.

Key words: emissivity, infrared thermography, FLIR measurement, military equipment.

Introduction

Thermal radiation plays an important role in the performance and survivability of military systems, and material emissivity is a critical parameter in controlling radiative heat transfer. Emissivity determines the thermal signature visible to infrared sensors. Its accurate characterization is essential not only for conventional engineering applications but also for military technologies, where thermal management and signature control are crucial for operational effectiveness (Modest, 2013).

The emissivity of a material surface is defined as the ratio between the radiant energy emitted by the material at temperature T and that emitted by an ideal blackbody at the same temperature. Thermal radiation represents electromagnetic radiation, typically comprising both visible radiation (light) and infrared radiation, the latter being invisible to the human eye. A fraction of thermal radiation originating from very hot objects is, however, easily detectable by sight (López et al., 2013).

The emissivity of a surface is strongly influenced by its chemical composition as well as its geometric structure. The emissivity coefficient ranges from 0 to 1.0 (King et al., 2017). A perfect blackbody (with emissivity equal to 1.0) emits thermal radiation of approximately 448 W/m² at a room temperature of 25 °C (298 K). Real surfaces with emissivity values lower than unity radiate proportionally less energy under identical thermal conditions (Liu et al., 2024).

The military significance of emissivity is primarily associated with the detectability of vehicles, aircraft, and naval vessels. Low-emissivity coatings are applied to reduce infrared signatures and enhance stealth capabilities, while high-emissivity surfaces are used to improve heat dissipation in critical systems (Ateia et al., 2021). For instance, armored vehicles employ specialized coatings to manage heat from engines and exhaust systems, reducing the probability of detection by enemy infrared reconnaissance systems. Similarly, missile casings and radar components utilize materials with tailored emissive properties to optimize thermal performance while minimizing detectability (Kim et al., 2017).

Emissivity also has direct implications for the thermal regulation of sensitive military components. Engineered surfaces with selective emissive properties, such as oxide layers, ceramic coatings, and nanostructured films, allow precise control over radiative heat transfer. These surfaces enable efficient heat dissipation from electronic housings, missile structures, and radar components while simultaneously minimizing thermal signatures (Králík et al., 2019).

Infrared thermography is a fundamental tool for analyzing surface temperature distribution and estimating material emissivity under realistic conditions. It allows for non-contact evaluation of thermal performance, which is essential for operational military systems (Salihoglu et al., 2018). Using high-resolution thermal imaging, engineers can identify hotspots, evaluate the effectiveness of thermal coatings, and monitor structural components subjected to variable thermal loads. For example, infrared imaging has been applied to monitor the thermal footprint of armored personnel carriers during field exercises, providing data critical for reducing detection risk and improving crew safety (Tran et al., 2021).

Modern FLIR (Forward-Looking Infrared) cameras provide practical methods for measuring emissivity in situ. These devices combine radiometric measurements with high-resolution imaging, allowing the determination of surface emissivity even on heterogeneous or non-uniform materials. By calibrating against reference surfaces, FLIR systems can correct apparent temperatures and yield accurate emissivity values, a process essential when evaluating complex coatings on metals, composites, or polymers used in military equipment (Lafargue-Tall et al., 2022).

The integration of infrared thermography and FLIR-based emissivity measurement has expanded the ability to quantify and model thermal behavior under field conditions. Real-time thermographic assessment of military systems improves maintenance, the identification of insulation failures, and the evaluation of coating degradation. Moreover, these techniques are applied during experimental trials to optimize material selection and surface treatments, balancing thermal efficiency with stealth requirements (Samolov et al., 2021).

This research focuses on the systematic characterization of the emissive properties of selected military-relevant materials using infrared thermography and FLIR measurement techniques. The investigation includes materials with varying surface treatments, such as metallic coatings, composite laminates, and polymeric films, reflecting the diversity of contemporary military hardware. This approach ensures a comprehensive evaluation, providing engineers with actionable data for the design of systems with enhanced operational performance under thermal and detection constraints. Using collected emissivity data, engineers can optimize material selection, surface treatments, and coating strategies, ultimately improving the survivability, efficiency, and stealth of critical military assets (Modest, 2013).

Several challenges complicate the reliable measurement of emissivity. First, emissivity is strongly angle-dependent, requiring integration over all emission angles or measurement at the most relevant ones. Second, it exhibits spectral selectivity, as infrared cameras detect only specific wavelength ranges (e.g., 8 – 12 μm), leaving emissivity outside those bands unaccounted for. Third, surface texture plays a major role: rough, oxidized, or contaminated surfaces often radiate differently compared to polished laboratory samples. Fourth, some materials display a pronounced temperature dependence of emissivity, as in the case of VO_2 and other phase-transition compounds. Finally, ambient reflections of infrared radiation can distort measurement results, particularly on metallic or low-emissivity surfaces. These challenges are especially critical in military applications, where accurate emissivity data are essential for camouflage optimization, thermal signature reduction, and infrared detection countermeasures (Salihoglu et al., 2018).

Materials and methods

Experimental setup

The measurement of emissivity was performed using a FLIR E40 infrared camera, which enables non-contact temperature determination by detecting infrared radiation from a material surface. Technical characteristics of the FLIR E40 camera may be found in our previous report (Boukera et al., 2022).

The procedure consisted of heating each sample uniformly in a drying oven (VIMS Elektrik, model VSSW-53, Figure 1a) until it reached a surface temperature of approximately 60 °C. The sample was then placed inside a high-emissivity cardboard protective enclosure, and its temperature was measured as it cooled spontaneously. The infrared camera was positioned at a distance of 1.0 m and oriented at a 45° angle relative to the sample surface in order to reduce reflection and minimize measurement errors (Figure 1b). The temperature measurements of the samples were conducted under controlled laboratory conditions, with an ambient temperature at 22 ± 1 °C and relative humidity below 50%.

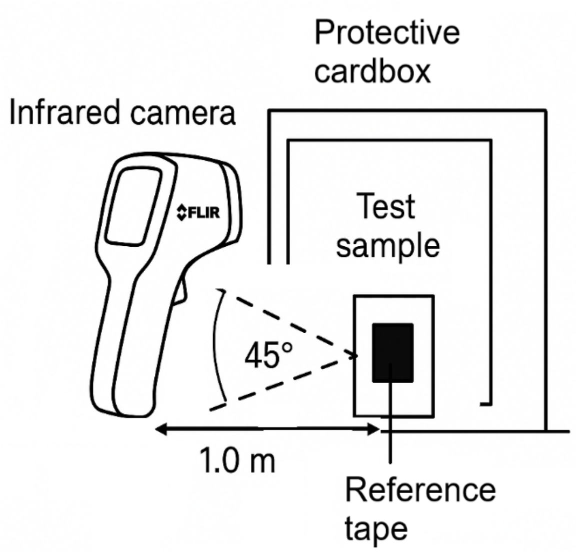

Figure 1 – Sample heating in the laboratory oven and the experimental setup scheme

The samples included metallic and polymeric surfaces with different surface treatments: bare steel, blued steel, wood, textile, polymers, and coatings. Each sample was cleaned with ethanol prior to measurement to remove dust and grease, since contaminants may significantly affect emissivity values (Liu et al., 2024).

Measurement procedure

Emissivity was determined using the direct method implemented in the FLIR software package. Namely, a matte black reference tape with a known emissivity coefficient of 0.95 (Boukera et al., 2022) was mounted onto the test specimens used for emissivity measurements, thereby ensuring thermal equilibrium between the plate and the specimen surface. In the first stage, the apparent temperature of the reference black tape was recorded by the FLIR camera, assuming a default emissivity value of 0.95. Then, the camera was pointed at the surface of the specimen, and the emissivity parameter in the software was iteratively adjusted until the measured infrared temperature matched the temperature of the reference tape. The resulting value was taken as the true emissivity of the sample surface (Boukera and Bouhidel, 2022).

The data collected by the FLIR camera were exported into FLIR Tools+ software for further processing. Emissivity maps were generated in order to visualize spatial variations across the surface. Statistical analysis was performed on three independent measurements for each sample to ensure repeatability, and the mean values were reported. The standard deviation (SD) was also calculated for each material and was found to be less than 0.050 in all cases, as shown in the tables below, which is acceptable for military applications where detection thresholds depend on relative rather than absolute differences (Liu et al., 2024).

Calibration of the FLIR camera was performed at the beginning of each measurement day using the black reference plate. To minimize reflections, the experiments were carried out in a darkened environment with no direct sunlight or artificial infrared sources.

Results and discussion

Tables 1 – 4 present both our experimentally obtained emissivity values and the reference values reported by Fluke and ThermoWorks databases (instrument manufacturer guidelines for emissivity adjustment) (Fluke Process Instruments, 2025; ThermoWorks, 2025) and other relevant literature sources. Representative infrared images are shown for different sample materials, where the attached plate appears as a distinct area of contrasting color, serving as a visual indicator of emissivity differences between the surfaces.

Table 1 - Emissivity of textile-based military equipment

Material	Average measured emissivity (ε)	Standard Deviation (ε)	Literature emissivity range (ε)
Serbian Armed Forces uniform, M10	0.87	0.034	0.90 – 0.98
Serbian Armed Forces uniform, M93 (Figure 2)	0.83	0.043	
Hook-and-loop insignia fastener (M10 uniform)	0.81	0.025	
Serbian Armed Forces insignia (Figure 2)	0.71	0.018	

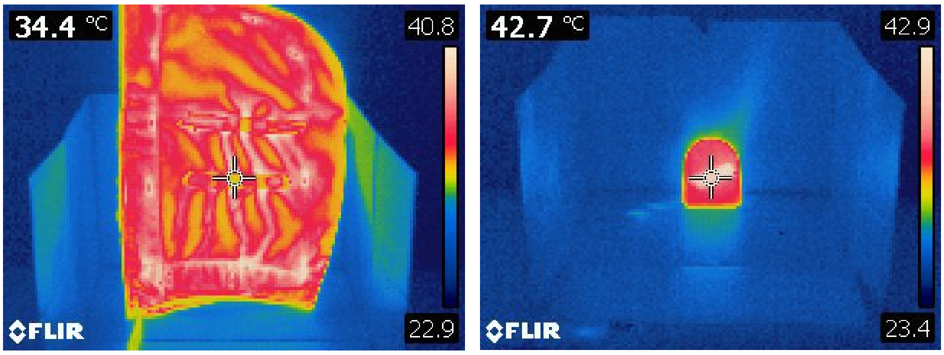

Figure 2 - Infrared images of the M93 uniform component and the insignia at the M10 uniform

The known emissivity values for cloth fabric range between 0.90 and 0.98, for black rubber are in the range of 0.94 – 0.95, and for leather are in the range of 0.95 – 0.98. Therefore, the measured emissivity values for military uniforms in our experiment (M10, M93) (0.83 – 0.87) are consistently lower than the reference emissivity range for generic fabrics. This discrepancy can be attributed to the presence of hydrophobic or flame-retardant coatings, specific dyeing processes (olive drab shade vs. black fabrics in literature), and surface wear and field use, which alter infrared reflectivity.

Hook-and-loop fasteners and insignia both show reduced emissivity (0.71 – 0.81) compared to textile standards, reflecting their plastic-based and partially reflective surfaces. This confirms that uniform accessories should be treated as distinct categories from fabric itself.

To achieve effective camouflage in the infrared region of the electromagnetic spectrum, the emissivity of a fabric must be engineered to approximate the thermal radiation characteristics of its surrounding environment. In natural terrains, vegetation represents the dominant background, and its emissivity is typically around 0.95, indicating the emissive behavior that camouflage textiles must replicate to minimize thermal contrast.

A variety of strategies may be employed to modify the emissivity of textile substrates. These include the incorporation of tailored pigments or nanostructured additives capable of altering the radiative properties of the surface, as demonstrated in the work on enhancing VIS and IR camouflage performance through PVB/IF-WS_2 impregnation of cotton fabrics (Samolov et al., 2021). Furthermore, emissivity can be adjusted by integrating metallic or other highly reflective layers into the textile architecture; however, such approaches often introduce undesirable reflections in the visible spectrum (Degenstein et al., 2021).

Table 2 - Emissivity of wooden components of military equipment

Material	Average measured emissivity (ε)	Standard Deviation (ε)	Literature emissivity range (ε)
Wooden ammunition box	0.85	0.024	
Wooden handguard for M70 assault rifle (Figure 3)	0.93	0.018	
Softwoods (spruce, pine)			0.80 – 0.90
Hardwoods (oak, redwood)			0.83 – 0.92
Processed wood (planed / varnished)			0.85 – 0.93
Plywood (smooth, commercial)			0.82 – 0.98

Measured emissivity values for wooden ammunition boxes and weapon handguards range from 0.85 to 0.93, which falls within the literature range for natural and processed wood (0.80 – 0.93) (López et al., 2013). This indicates that our measurements for wood are more consistent with reference values than those of the textile group. One may conclude that wooden components of military equipment are highly emissive and therefore are easily detectable in thermal imaging, which is important for assessing camouflage effectiveness in the field.

The measured emissivity values for metallic components generally fall within or slightly below the range reported in the literature. The measured emissivity of the M70 bolt carrier (ε = 0.51) is consistent with literature values for unpolished/rough steel (ε ≈ 0.30 – 0.60), indicating a machined or lightly oxidized surface finish rather than a mirror-polished treatment

(Howell et al., 2010). Brass components show intermediate values that correlate well with literature data.

Table 3 - Emissivity of metallic parts of military equipment

Material	Average measured emissivity (ε)	Standard Deviation (ε)	Reference ε (Fluke)	Reference ε (ThermoWorks)
Bolt carrier with bolt, M70 assault rifle (alloy steel, polished finish) (Figure 3)	0.51	0.034	0.30 – 0.60 for unpolished steel	
Brass 76 mm M58 shell (Figure 3)	0.73	0.008	0.69	0.61
Brass 20 mm M69 cartridge (Figure 3)	0.61	0.016	0.69	0.61
Blued (burnished) steel components				
Slide assembly with bolt for M57 pistol (Figure 3)	0.54	0.016	0.60 – 0.95	
Slide cover for CZ99 pistol	0.67	0.005		
Receiver cover for M70 assault rifle	0.75	0.042		
Detachable box magazine, 30-round, for M70 assault rifle (Figure 4)	0.64	0.029		
Detachable box magazine, 9-round, for M57 pistol	0.67	0.016		
Detachable box magazine, 15-round, for CZ99 pistol	0.72	0.017		

The measured emissivity values for the burnished components of Serbian small arms, including the slide assembly with bolt for the M57 pistol (ε = 0.54), slide cover for the CZ99 pistol (ε = 0.67), receiver cover for the M70 assault rifle (ε = 0.75), and various detachable box magazines (ε = 0.64 – 0.72), are generally lower than the emissivity reported in literature for similarly treated steel surfaces. According to Fluke Process Instruments, oxidized steel surfaces exhibit emissivity values near 0.95, while for polished steel it can be as low as 0.07 (Fluke Process Instruments, 2025). Similarly, Omega Engineering reports an emissivity of blued steel around 0.79, depending on the thickness of the oxide layer and surface roughness (Omega Engineering, 2025). These reference values suggest that our measured results are systematically lower, likely due to experimental factors such as ambient reflections, the finite angle of infrared detection, and possible local variations in the oxide layer.

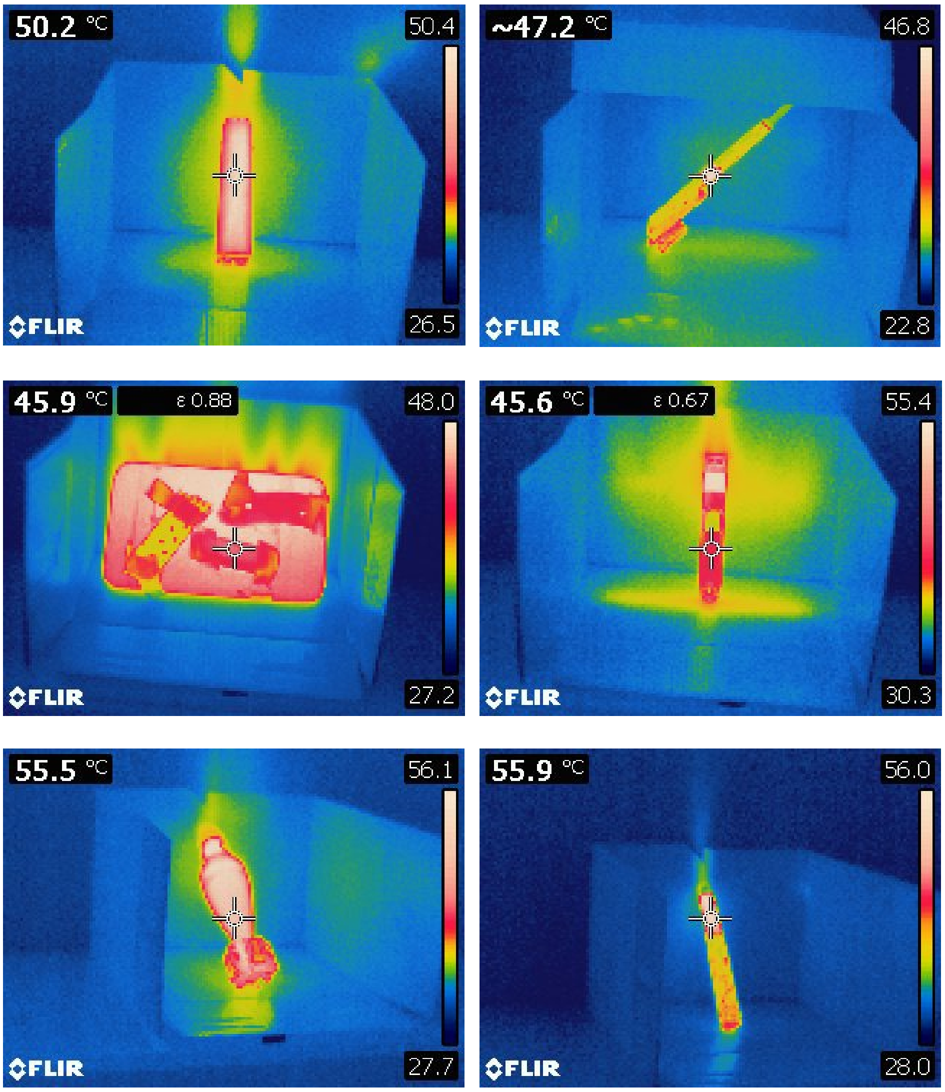

Figure 3 - Infrared images of the weapons and ammunition parts: wooden handguard for the M70 assault rifle; bolt carrier for the M70 rifle; the M57 pistol components; slide assembly for pistol M57 pistol; brass 76 mm M58 shell; and brass 20 mm M69 cartridge

The variation observed among the measured parts: ε = 0.54 for the M57 slide versus ε = 0.75 for the M70 receiver cover—may reflect differences in surface finish, machining, or oxidation procedures. Surface characteristics of metals, including sandblasting, increased roughness and oxide layer thickness, strongly influence emissivity. Increased roughness enhances surface–radiation interaction by creating more microfacets and trapping emitted radiation, typically increasing emissivity by 0.05–0.15 for steels, whereas oxidation can raise emissivity more substantially, from ~0.3–0.5 up to ~0.6–0.8, depending on material and treatment conditions, because the oxide layer is less reflective and more absorptive in the infrared, efficiently emitting thermal radiation (King et al., 2017).

Burnishing, also known as bluing or black oxide coating, is a conversion treatment that forms a thin magnetite (Fe_3O_4) layer on steel, enhancing corrosion resistance and yielding a characteristic dark appearance (Oberg & Green, 2004). Importantly, the thermal radiative properties of such coated metals are highly dependent on surface condition. Oxidized or black-oxide-treated surfaces exhibit markedly higher emissivity compared to their polished or untreated counterparts, primarily due to increased surface roughness and absorption characteristics. This relationship is well-documented in studies exploring the influence of surface treatments on metal emissivity (Králík et al., 2016).

Overall, these measurements highlight that while burnished steel significantly increases thermal emission compared to polished steel, our results suggest a moderate underestimation relative to literature values. For future measurements, consideration of angle-dependent emissivity corrections and accounting for ambient infrared reflections could improve accuracy (Modest, 2013). Despite these limitations, the measured emissivity values remain consistent with expected behavior for darkened steel surfaces and can inform infrared-based detection or thermal analysis of similar military equipment.

Plastics, polymers and dark-colored organic coatings exhibit generally high emissivity values, typically ranging between 0.80 and 0.95 (Fluke, 2025; ThermoWorks, 2025), and our results fall within this range. Interestingly, the emissivity measured for the polymer of the M19 rifle was even higher than that of the black insulating tape employed as a reference standard in our experiments. A plausible explanation for this observation lies in surface texture: the insulating tape has a smooth finish, whereas the black polymer on the rifle exhibits a slightly roughened surface. It is well-established that microscale surface roughness increases the effective emissivity by enhancing absorption and scattering of thermal radiation, thereby reducing reflection (Modest, 2013).

Table 4 - Emissivity of polymeric materials and coated surfaces of military equipment

Material	Measured ε	Standard Deviation (ε)	Reference ε (ThermoWorks)
VMRUD anti-personnel mine, olive drab plastic casing	0.92	0.000	0.93 – 0.95 (for dark plastic)
60 mm M57 mortar shell, olive drab coating	0.93	0.005	
Pistol grip (carved section) for M57 pistol	0.86	0.005	
Receiver cover for M19 assault rifle, polymer (Figure 4)	0.99	0.000	
Detachable box magazine, 30-round, for M19 assault rifle, polymer (Figure 4)	0.99	0.000	

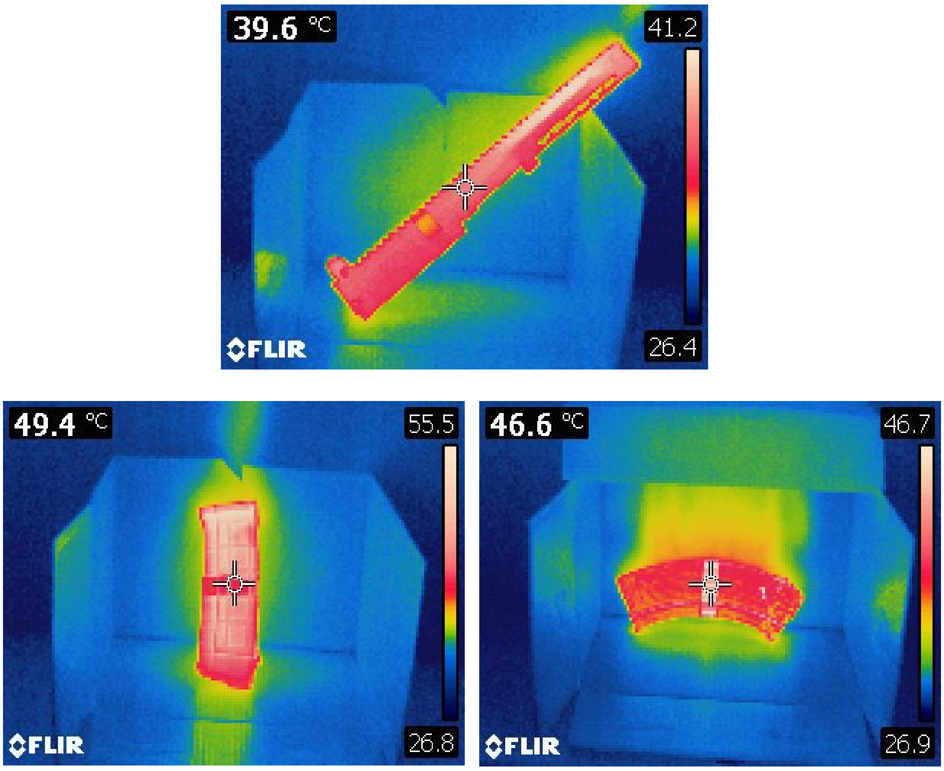

Figure 4 - Infrared images of the receiver cover for the M19 rifle; box magazine for the M19 rifle (left), and the M70 rifle (right)

For visual comparison, Figure 4 presents thermal images of the two box magazines with different emissivity values (ε = 0.99 for the M19 rifle and ε = 0.64 for the M70 rifle), each covered with a high-emissivity black tape (ε = 0.95). It can be visually observed, even without numerical analysis, that the tape appears darker than the high-emissivity substrate and brighter than the low-emissivity substrate. This occurs because high-emissivity surfaces emit thermal radiation more efficiently and therefore appear closer to their true temperature in infrared images, while low-emissivity surfaces emit less radiation and reflect more of the cooler surroundings, causing them to appear artificially colder compared to the tape.

From a practical perspective, this high emissivity has implications for thermal signature and infrared detectability. Surfaces with emissivity closer to a perfect black body emit thermal radiation more efficiently, which can make them more conspicuous under infrared observation, as these components would appear relatively "hot" under infrared observation. Therefore, while the polymer's mechanical and protective properties may be advantageous, its elevated emissivity could be a limiting factor for thermal camouflage in operational environments. This highlights a trade-off in material selection between durability, aesthetics, and infrared signature management in military applications.

Conclusion

The comprehensive emissivity measurements of military-relevant materials conducted in this study confirm both the reliability and rapidity of the FLIR-based method, which demonstrated consistent agreement with tabulated emissivity values. The deviations observed were minor for most classes of materials, although metallic surfaces systematically exhibited slightly lower emissivity compared to literature data, primarily due to surface finish and ambient reflection effects. Military textiles such as M10 and M93 uniforms showed emissivity values in the range of 0.83–0.87, notably lower than the generic fabric range (0.90–0.98), indicating the influence of coatings and treatments. Wooden components of weapons and ammunition boxes yielded emissivity values of 0.85–0.93, which are in close alignment with literature ranges for natural and processed wood (0.80–0.93), confirming their highly emissive and thus easily detectable nature. Metallic weapon parts, such as the M70 bolt carrier (ε = 0.51) and blued steel magazines (ε = 0.64–0.75), fell within expected ranges but slightly underestimated compared to standard references, underlining the importance of accounting for oxidation layers and surface preparation. In contrast, polymeric and coated surfaces exhibited high emissivity values (0.86–0.99), in full agreement with ThermoWorks and Fluke data, with polymer magazines and M19 rifle components approaching blackbody-like behavior (ε ≈ 0.99).

Overall, this work provides a robust dataset of emissivity values across textiles, wood, metals, and polymers commonly used in Serbian military equipment, with results directly comparable to established databases. Building on the work of Samolov et al. (2021), our study addresses the continuous need within the Serbian Armed Forces for materials that enhance infrared camouflage capabilities. Importantly, the applied FLIR thermography method proved to be a fast, practical, and reliable approach for emissivity characterization, enabling rapid measurement in both field and laboratory conditions. This research equips engineers of the Serbian Armed Forces with a practical tool for evaluating and improving IR camouflage strategies, ultimately enhancing operational survivability and reducing the probability of detection.

References

Ateia, E. E., Metwaly, M. A. & Tantawy, H. R., 2021. Low thermal emissivity coating based on aluminium/acrylic composite coatings. IOP Conference Series: Materials Science and Engineering, 1172(1), 012027. https://doi.org/10.1088/1757-899X/1172/1/012027

Boukera Abaci, W., Hristov, N., Ziane Ahmed, N., Jerkovic, D. & Drakulic, M., 2022. Determination of the gun barrel walls temperature distribution and its experimental validation during multiple-shots firing process. International Journal of Thermal Sciences, 179, 107667. https://doi.org/10.1016/j.ijthermalsci.2022.107667

Degenstein, L., Sameoto, D., Hogan, J., Asad, A., Dolez, P., Smart Textiles for Visible and IR Camouflage Application: State-of-the-Art and Microfabrication Path Forward. Micromachines, 2021 12(7):773. https://doi.org/10.3390/mi12070773

Fluke Process Instruments, 2025. Emissivity Values for Common Materials. Available at: https://www.fluke.com

Howell, J., Siegel, R. & Mengüç, M. P., 2010. Thermal Radiation Heat Transfer. Fifth Edition. CRC Press. ISBN: 1439805334. https://doi.org/10.1201/9781439894552

Kim, T., Kim, T., Bae, J.-Y., Jung, D., & Cho, H.-H. (2017). Infrared Signature Analysis on Armored Vehicle Applied with Emissivity Controlled Structure. Journal of the Computational Structural Engineering Institute of Korea, 30(2), 179–184. https://doi.org/10.7734/COSEIK.2017.30.2.179

King, J. L., Jo, H., Tirawat, R., Blomstrand, K. & Sridharan, K., 2017. Effects of surface roughness, oxidation, and temperature on the emissivity of reactor pressure vessel alloys. Nuclear Technology, 199(3), 329–343. https://doi.org/10.1080/00295450.2017.1353869

Králík, T., Hanzelka, P., Musilova, V. & Srnka, A., 2014. Factors influencing thermal radiative properties of metals. Refrigeration Science and Technology, 239–247. https://doi.org/10.48550/arXiv.1610.00915

Lafargue-Tallet, T., Vaucelle, R., Caliot, C., Aouali, A., Abisset-Chavanne, E., Sommier, A., Peiffer, R. & Pradere, C., 2022. Active thermo-reflectometry for absolute temperature measurement by infrared thermography on specular materials. Scientific Reports, 12, 11616. https://doi.org/10.1038/s41598-022-11616-8

Liu, Y., Long, L., Gao, Y., Li, W., Tang, Z. & Ye, H., 2024. Influence of emissivity on infrared camouflage performance. Infrared Physics & Technology, 141, 105509. https://doi.org/10.1016/j.infrared.2024.105509

López, G., Basterra, L. A., Acuña, L. & Casado, M., 2013. Determination of the emissivity of wood for inspection by infrared thermography. Journal of Nondestructive Evaluation, 32(2), 172–176. https://doi.org/10.1007/s10921-013-0170-3

Modest, M. F., 2013. Radiative Heat Transfer, 3rd Edition. Academic Press. https://doi.org/10.1016/C2010-0-65874-3

Omega Engineering, Inc., 2025. Table of Total Emissivity – Metals, Technical Reference Z-88/Z-89. Available at: https://www.omega.com

Salihoglu, O., Uzlu, H. B., Yakar, O., Aas, S., Balci, O., Kakenov, N., Balci, S., Olcum, S., Süzer, S. & Kocabas, C., 2018. Graphene-based adaptive thermal camouflage. Nano Letters, 18(7), 4541–4548. https://doi.org/10.1021/acs.nanolett.8b01746

Samolov, A. D., Simić, D. M., Fidanovski, B. Z., Obradović, V. M., Tomić, L. D., & Knežević, D. M. 2021. Improvement of VIS and IR camouflage properties by impregnating cotton fabric with PVB/IF-WS_2. Defence Technology, 17(6), 2050–2056. https://doi.org/10.1016/j.dt.2020.10.008

ThermoWorks, 2025. Material Emissivity Table. Available at: https://www.thermoworks.com

Tran, T. B. & Hoa, T. M. 2025. Experimental research and evaluation of thermal camouflage effectiveness of advanced materials for mobile vehicles. Journal of Military Science & Technology, 102, 109–117. https://doi.org/10.54939/1859-1043.j.mst.102.2025.109-117

Oberg, E., Jones, F. D., Horton, H. L. & Ryffel, H. H., 2004. Machinery's Handbook. Industrial Press, New York

Eksperimentalno određivanje površinske emisivnosti za komponente vojne opreme i poređenje sa referentnim podacima

Lazar Z. Lazarević, *Nebojša* P. Hristov, *Damir* D. Jerković, *Darko* R. Latinkić, *Mihael* M. Bučko, **autor za prepisku**
Univerzitet odbrane u Beogradu, Vojna akademija, Beograd, Republika Srbija

OBLAST: mašinstvo, materijali
KATEGORIJA (TIP) ČLANKA: originalni naučni rad

Sažetak:

Uvod/cilj: Cilj ovog rada bio je da se ispita emisivnost materijala relevantnih za Vojsku Srbije i oceni njihova uloga u upravljanju infracrvenim potpisom i efektivnosti kamuflaže. Emisivnost je kritičan parametar koji utiče na termičku detektabilnost objekata, jer površine sa većom emisivnošću emituju više infracrvenog zračenja i samim tim postaju vidljivije za termovizijske sisteme.

Metode: U ovoj studiji, vrednosti emisivnosti tekstila, drveta, metala i polimernih komponenti izmerene su termografskom metodom FLIR. Primenjeni pristup se pokazao brzim i pouzdanim, sa rezultatima koji su u skladu sa utvrđenim referentnim podacima.

Rezultati: Razlike između klasa materijala bile su očigledne: tekstil i polimeri generalno pokazuju visoku emisivnost, metali imaju niže vrednosti jako zavisne od obrade površine, dok drvene komponente ostaju visoko emitivne i samim tim više izložene detekciji. Ovi rezultati potvrđuju da emisivnost zavisi od tipa materijala, završne obrade površine i premaza.

Zaključak: Rezultati pružaju sveobuhvatan skup podataka za materijale relevantne za vojnu upotrebu i naglašavaju praktičnu važnost karakterizacije emisivnosti u razvoju efektivnih kamuflažnih strategija. Integrisanjem preciznih podataka o emisivnosti u modelovanje infracrvenog potpisa, postaje moguće optimizovati dizajn kamuflaže i produžiti operativnu upotrebu smanjenjem verovatnoće detekcije na bojnom polju.

Ključne reči: emisivnost, infracrvena termografija, FLIR merenje, vojna oprema.

Paper received on: 3 September 2025.
Manuscript corrections submitted on: 17 November 2025.
Paper accepted for publishing on: 24 November 2025.