Materials Physics Terminology

Word [units]	**Definition**	**How can you tell?**	**Opposite**
Breaking or Fracture Stress [Nm^{-2} *or* Pa]	Stress at the point of fracture	Last (not necessarily the highest) point on σ-ε graph.	n/a
Brittle	Small deformation before fracture. Fractures by cracking.	Short (usually high gradient) linear region on σ-ε graph	Tough
Ductile	Can be drawn into a wire. Does not crack.	Plastic region on σ-ε graph is large	Brittle
Elastic	No permanent deformation after removal of stress.	Unloading curve returns to same point as the loading curve started from. σ-ε graph probably has significant linear region.	Plastic
Hardness [no units*]	Little indentation for a given σ	Not easily, but if something has a high Young's modulus and/or high Yield point, it's *likely* to be hard.	Softness
Hookean	Obeys Hooke's Law (*i.e.* that $\sigma \propto \varepsilon$)	σ-ε graph has an initial linear region	Non-Hookean
Malleable†	Can be beaten into sheets	Plastic region on σ-ε graph is large	Brittle
Plastic	Applying a force and removing it deforms the sample permanently.	Unloading curve does not return to same point as the loading curve started from.	Elastic
Stiff	Large value of E	Initial linear region on σ-ε graph has high gradient	n/a
Stiffness [Nm^{-2} *or* Pa]	Young's Modulus	$= \frac{\sigma}{\varepsilon}$ at any point on graph, but usually in initial linear region	n/a
Strength	= UTS	See under UTS	Weakness
Tensile Stress	Any stress you are referring to which is < UTS when material is under tension	n/a	Compressive Stress
Toughness [Jm^{-3} OR Jm^{-2}]‡	Energy absorbed per unit Volume before fracture OR Energy used per new area created during fracture.	Large Plastic region on σ-ε graph (plastic deformation absorbs energy); large area beneath the σ-ε curve§	Brittle
Ultimate Tensile Stress (UTS) [Nm^{-2} *or* Pa]	Maximum σ material can take before breaking	Highest point on σ-ε graph.	n/a
Yield Point/ Yield Stress	When structure of the material is being changed. More strain is not necessarily caused by more stress.	First "mini-peak" on typical (*e.g.* steel) σ-ε graph**	n/a

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* This is not *strictly* true. Hardness has to be measured using a standardised test: Vickers and Brinell tests are two of the most commonly used. Hardness is then quantified as a number without units (*e.g.* "Vickers Hardness = 440 HV")

† Ductile and Malleable are practically the same thing, but ductile refers to the effect of a tensile force; malleable to the effect of a compressive force. The opposite word (brittle) applies to both tensile and compressive situations.

‡ Some sources use Jm^{-2}, but many other respectable sources use Jm^{-3} due to using slightly different defining situations.

§ Strictly, the toughness is measured by measuring the area (*i.e.* integrating) beneath the σ-ε graph. If you are measuring toughness just for the Hookean region of the graph, Toughness $= \frac{1}{2}\sigma\varepsilon$. This gives the units as Jm^{-3}.

** The Yield point is notoriously difficult to measure, as it is impossible to know when the internal structure of a material is being changed whilst you are actually testing it. For simplicity, the yield point is often taken to be synonymous with either the limit of proportionality and/or the elastic limit. For most materials in most practical situations this is good enough.